

CHIRIQUEI COMMISSION.

MESSAGE

FROM

THE PRESIDENT OF THE UNITED STATES,

TRANSMITTING

Reports from the Chiriquei commission.

JANUARY 22, 1861.—Referred to the Committee on Naval Affairs, and ordered to be printed without the maps.

To the House of Representatives:

I herewith transmit to the House of Representatives a communication from the Secretary of the Navy, with accompanying reports of the persons who were sent to the Isthmus of Chiriquei to make the examinations required by the 5th section of the act making appropriations for the naval service, approved June 22, 1860.

JAMES BUCHANAN.

WASHINGTON, *January 22, 1861.*

NAVY DEPARTMENT, *January 22, 1861.*

SIR: I have the honor to transmit herewith the reports of the persons who were sent, in pursuance of the 5th section of the naval appropriation act of June 22, 1860, to the Isthmus of Chiriquei "to examine into and report upon the quality and probable quantity of coal to be found there upon the lands of the Chiriquei Improvement Company; upon the character of the harbors of Chiriquei lagoon and Golfito; upon the practicability of building a railroad across said isthmus, so as to connect said harbors; and generally upon the value of the privileges contracted for in a conditional contract made on the twenty-first day of May, eighteen hundred and fifty-nine, between Isaac Toucey, the Secretary of the Navy of the United States, and Ambrose W. Thompson and the Chiriquei Improvement Company."

I am, very respectfully, your obedient servant,

I. TOUCEY.

The PRESIDENT of the United States.

1. On the Atlantic side

2. " Pacific "

Report of Captain Engle.

WASHINGTON, January 6, 1861.

SIR: The final reports and charts of the topographical, engineer, hydrographer, and geologist, will explain clearly the three months' work of the Chiriqui commission; they being successful, leaves me but little to say except to refer you to them.

The officers being competent executors of the work of their divisions, will show by their charts and writings that your anticipations have been fully realized.

Harbors incomparable, of a size unequalled, depth of water in their three main entrances for our largest ships to enter without pilots, and when fairly within can run on any course with certainty, and anchor in good holding ground without fear of any one of the numerous injuries connected with the life of a seaman.

The shores in most places are bold; should it be necessary to wharf for the accommodation of merchant ships, it will only be to give a solid, clean, and clear place to load and discharge, for they can now haul alongside the banks and secure to them. Wood for wharfing or other purposes is at hand. This also may be said of the Pacific harbor. The entrance to Golfito is perfectly clear, and the harbor for safety, or in points to facilitate trading vessels, quite equal to that of Chiriqui, but in size or grandeur neither that nor any other can be compared to it.

The geologist satisfactorily shows the quantity of coal on the islands, but particularly on the tributaries of the Changuinola river, to be abundant, as well as of an excellent quality for commercial purposes.

The neares point from whence to ship the coal, I think, will be found to be Boca del Drago, which is the main channel to the beautiful, great, and grand Almirante bay, thirteen miles long and eight broad, connecting with those of Boca del Toro, Shepherd's harbor, and Poros and Palos lagoons. The two latter are more like large docks, their entrances are narrow, not over one hundred feet wide, with a channel of from eight to ten fathoms of water. When a ship is in her length, on looking around you discover yourself in a land-locked basin of three and a half by one and a half miles. Then at the foot of Almirante bay, "so called from its having been discovered by Columbus in October, 1503, where he remained ten days," lies Shepherd's island, cutting off one and a quarter miles of it by three and a half long, forming a complete place for the terminus of a railroad. There is a channel at each end of the island, giving to sailing vessels a fair wind at all times.

This harbor, for its facilities for wooding, watering, and easy access, with its natural beauties, makes its mark on the minds of navigators never to be forgotten. The island is two hundred and sixty-four feet high, and can be made a spot of immense strength and beauty. The batteries from it would command the entrances as well as the whole harbor and terminus of a railroad on the southern shore. The average

height of the highest points of the islands within the harbors is four hundred and fifty feet.

Whenever this railroad is opened, of the feasibility of which the topographical engineer entertains no doubt, these harbors cannot longer remain idle, for the road will pass through a country of gold, coal, minerals, lands which produce every fruit of the tropics of the highest order—coffee, cocoa, indigo, rice, cotton, oranges, lemons, limes, &c. It is much easier to say what it does not produce than what it does, for everything seems to vegetate and give the best of its kind. Then, on the Pacific, the plains are large, and no bounds to the scope of pasture for raising cattle.

At this early day I call the attention of the engineers and managers who may locate the road, to an examination of the line from the “Three Branches” of the Robalo river to Shepherd’s harbor. The present proposed line will touch the “Three Branches.” It is not much further, if any, from them to Shepherd’s harbor than to Frenchman’s creek.

This harbor is near the coal mines on the Changuinola river, where the valleys, by the report of the geologist, are thirty miles long by twenty broad, and where, on the Atlantic side, must be the position for active trade in coal, agriculture, cattle raising, &c. The hills are not so high, nor are they so rough, as those about Frenchman’s creek; some of them are now cultivated, and all can be. But the strongest recommendation is, that after entering Boca del Drago you have but twelve miles to run, passing through the most beautiful harbor of this magnificent group—no shoals, all clear.

To Frenchman’s creek from Boca del Drago, is forty-two miles. You pass through the Boca del Tigre, a fine, wide, open channel, which only requires a fort on Watercay to command it, and a light for navigators to clear the Tiger breaker, as well as for a point to determine the course to be steered through the shoals to the southward of it. Then you have twenty miles of smooth harbor surface to steam before reaching Frenchman’s creek, the now proposed terminus of the road, which would increase the steaming distance from any of our ports, *via* Cape San Antonio, thirty miles each way. Examine the line for Shepherd’s harbor. Boca del Drago has Columbus island on its east and the main on its west. On entering the channel you make a sharp angular turn and head for the main, where there should be a fort; from this point you have two raking fires, which no ship or ships can stand, for you have to face the muzzle to a distance of fifty yards, then broadside, and then “stern to.” Near this point must be the great depot for the coal from the mines, which must be brought there for shipment. It is the most available point; the distance to Changuinola is six miles.

I have said but little of the road. When the government employs able and efficient officers it is better they should speak for themselves; but this does not prevent me, in a general way, from noticing the conducting of their commands when absent.

In my preliminary report I mentioned the satisfactory manner in which the hydrographer, Lieutenant Jeffers, United States navy, and the geologist, Dr. Evans, had performed their duties, and now I am

able to speak of J. St. C. Morton, of the topographical engineers, United States army. Lieutenant Morton had a large range of heavy work to go through between the two oceans. Pursuing his course over the Guaroma route, he arrived at the "Alto Boquete," where he formed the "initial point," and separating his party into two divisions, he left one to explore the passes to the Atlantic, whilst he led the other to Golfito, on the Pacific. Returning thence, he learned that the Atlantic party, by following the course indicated in his instructions, viz: "from the monument upwards the survey is to include the topography of the bed and sides of the cañon, and the course of the river *up to its source*," had overlooked the chasm of the cañon, which, by Lieutenant Morton's report, opens a pass to the plains. Lieutenant Morton, with a decision and energy worthy of high praise, entered personally into the re-survey of this portion of the route, and has reported the result: that the cañon opened a "practicable" passage for a railroad from the valleys of the Atlantic slope through the Cordilleras to the plains of the Pacific.

If there had been sufficient time, Lieutenant Morton would have been directed to examine and survey the other passes designated by Dr. Evans, which, he states, were discovered or observed by him during his geological explorations; and that they have lower grades than the one surveyed by Lieutenant Morton. The twelve years' experience which Dr. Evans has had as government geologist and surveyor in the Rocky mountains, entitles his opinions to consideration.

The results of the explorations and surveys made by the Chiriqui commission are thus demonstrated: by Lieutenant Morton, that a practicable route for a line of railroad has been found between the two oceans, on the Isthmus of Chiriqui.

By Lieutenant Jeffers, the hydrographer, that the great and grand harbors at its termini afford every requisite for the protection of naval and commercial marine, and for all practical purposes, to an unlimited extent. And by Dr. Evans, the geologist, that the best coal for steam navigation exists at and near the Atlantic harbors of the Chiriqui lagoon.

I have the honor to submit herewith my report.

Very respectfully, your obedient servant,

F. ENGLE,

Captain, Commanding Chiriqui Commission.

Hon. ISAAC TOUCEY,

Secretary of the Navy, Washington, D. C.

Report of the officer in charge of the topographical division of the Chiriqui commission.

WASHINGTON CITY, *January 16, 1861.*

SIR: I have the honor to submit the following report of the topographical division of the exploration and survey, directed by the President of the United States, under the third section of the naval

appropriation act approved June 22, 1860, to ascertain the practicability of a railroad over the Isthmus of Chiriqui, between the harbor of Chiriqui lagoon, on the Atlantic side, and that of Golfito, in the Gulf of Dulce, on the Pacific; and the value of the privileges generally secured in a contract, as recited in said act, between the United States and Ambrose W. Thompson.

I also submit a topographical map of the isthmus, and two barometrical profiles across it, together with views of the most striking portions of the country. My assistance was limited, both by the amount of the appropriation, which was small, and the difficulty of providing for a numerous party in such regions as had to be explored; it consisted of Messrs Jekyll, Wilson, Babcock, and Engle, jr., surveyors, and two chainmen, Messrs Pearsall and Ramsay. On the 13th of August we sailed from Norfolk in the United States steamship Brooklyn, and arrived at Boca del Toro, on the Chiriqui lagoon, on the 23d.

I there procured a guide, Mr. Shepherd, and, upon consultation, was advised that the best course would be to penetrate to the interior by the "Guaromo route," used by the natives in crossing the mountains, proceed to the cañon designated by Mr Ambrose Thompson, jr., (who had some months previously visited this section, and now accompanied the expedition by authority of the honorable Secretary of the Navy,) and then to divide the party, so that one division should be engaged on the survey of the Atlantic, the other of the Pacific slope. This plan involved considerable fatigue to the party before they could commence the work, properly speaking, but there was no alternative, since I could find no one who would undertake to guide me to the "pass" from the Atlantic side.

The Brooklyn arrived off the mouth of Frenchman's creek, another point of the lagoon, on the 24th of August. I visited that point and Fish creek on the same day, and decided to establish my barometrical station and depot at the latter place. I appointed Mr. Wilson to remain in it until sent for by me, providing him with four Green's cistern barometers and one French one, and left detailed instructions in regard to the manner in which the readings were to be taken and recorded, which, with the results obtained, will be found accompanying the barometric tables appended to this report.

On the 25th I hired a force of nine natives to carry my instruments and baggage across the mountains, and started at noon for the interior with all my party except Mr. Wilson. The natives are accustomed to such work, and can pack, on an average, three arrobas or eighty-four pounds, making the transit in four or five days between Fish creek and Caldera. I took a tent without walls, a set of field surveying instruments, and a Green's cistern barometer; each member of the party was allowed twenty pounds of baggage.

The most difficult march on the Guaromo route is that of the second day, when it is necessary to follow the bed of the river for about four hours. At the affluence of the Corrieto the slope of the stream becomes much steeper, and its bed narrower; the route there takes up that branch a short distance, and then, leaving it behind, follows the western slope of the Guaromo valley, crossing the ravines which supply its tributaries, the Chiriqui and Bijao, and the ridges

and spurs which separate them, without much regard to selecting the easiest ascents and descents, and finally attains the sources of the river in the depression that exists between the Monte Frio (whose northern slopes it drains) and the peak to the eastward of it.

We crossed the divide named that of Monte Frio, which is a sharp ridge of the altitude of 5,577 feet, on the 29th, and entered a most rugged and difficult region, which contains the headwaters of the river Chiriqui Grande, and, after crossing numerous sharp spurs radiating from a high peak, around which the path winds, entered the valley of that river and followed its right or western slope.

On the Pacific side the descent is, after reaching the savannas which are met with at an altitude of 1,500 feet, much easier than on the Atlantic slope.

The chief difficulty in traversing them is the crossing of the streams, which are violent mountain torrents with rocky beds, and flow in deep and difficult gullies or barrancos. The chief ones are the Algarobo and Rio de las Valles. We reached a village of half a dozen houses called Caldera on the morning of the 31st; here I hired a party of five natives to go to Fish creek and return with Mr. Wilson; I also sent to David, the capital of the province, which is about 16 miles below Caldera, for provisions.

At noon, on the 3d of September, the provisions arrived from David; and we set off at 1 p. m. towards the pass. The route from Caldera crosses the river of that name, which is a mountain torrent of considerable size, flowing in an uncommonly large "barranco," and follows up its right bank, which constantly becomes higher and steeper. The general course of the road from Fish creek to Caldera is about south 25° west, (true,) and from the latter point to the entrance of the pass the bearing is north 23° west, and lies over savannas, which can easily be travelled by horses. A day and a half's march brought us on the 5th of September to the hacienda of Don Lorenzo Gallego, the prefect of the province, which is situated at what my guide called "the mouth of the pass."

I at once made a reconnoissance, accompanied by Mr. Shepherd, and penetrated as far as his knowledge extended, viz: to include the point where it will be seen in the sequel the railroad location I subsequently laid down crosses the cañon. I also reconnoitered down the cañons of Caldera and Cochea, to a point about eight miles below the hacienda.

My special object in these reconnoissances was to ascertain at what point the road could most readily be brought out of the Caldera cañon or "pass" to the level of the savanna, supposing that it could be brought into it from the shores of the lagoon. But here, in order that my operations and those of the party may be followed, it is necessary to give a brief description of the field of survey.

In attempting to impart a general idea of the topographical features of the country, I find it contributes to perspicuity to mingle with the description some theoretical views in regard to its formation. It would appear that, at an epoch not very remote, geologically speaking, the chain of mountains which forms the backbone of this point of Central America was upheaved from beneath the water level, and that the

Isthmus of Chiriqui at first consisted simply of the great longitudinal ridge with its offshoots or spurs, whose rocky sides rose out of the sea, with no intervening plain or swamp between their base and deep water. The central ridge has a general direction of nearly east and west; it seems to be formed of a succession of cones or peaks, from each of which radiate spurs likewise furnished with their secondary offshoots. Where these interfere with each other, there results a complication of ravines and precipices that defies description; but at two or three points the system is arranged with some regularity, and the country, though wild, is not impracticable. The ridges are, throughout, exceedingly sharp; on those of the main spurs there is seldom more room than is needed for the double track of a railroad, while on the secondary ones there is often hardly width enough for a pathway for foot travellers. The side slopes are steep near the top, become gentler half way down, and steep again near their base.

The two peaks that lie to the southward of the Chiriqui lagoon and to the eastward of the great volcano are named the "Monte Frio" and the "Monte Horqueta." Between the former and the one next to the eastward, which has not been named, is the depression in which the Guaromo river rises, and which is traversed by the route of that name; in that which lies between the "Volcan," a great volcano of Chiriqui, and the "Monte Horqueta," was alleged to exist the pass by which a route for a railroad might cross the chain. It will be seen that the exploration proved an impracticable country to exist in that quarter, but discovered a practicable pass between Monte Horqueta and Monte Frio.

The above description will answer to give a general idea of the Atlantic or north side of the Isthmus of Chiriqui, if it is added that the sharp and narrow gorges of the rivers have become filled up in the course of ages by alluvial deposits so as to form swamp or low flat lands, which spread out near the sea into valleys of some width, lying in directions oblique to the sea-coast. On the Pacific side, however, other causes, and vastly greater than those due to the effects of climate and temperature, have operated since the upheaval of the mountain chain to change the face of the country. Looking northward from almost any point of the Pacific coast, the most careless observer will notice a certain cleft appearance in the range of the Cordilleras, which, with many other peculiarities that I have endeavored to depict in the sketches of the country which accompany this report, indicate that at an epoch not very remote, geologically speaking, the peaks must have been frequently rent asunder to give vent to inconceivably great eruptions of lava, which deluged the whole western slope of the isthmus and filled up its ravines, and buried and smoothed over its sharp peaks and cliffs and precipices, and which, the surface having become disintegrated and covered with grass, now form the beautiful green savannas which sweep down to the Pacific with so regular a slope that the eye can take them in at a glance from a single point of the mountains.

Half the province of Chiriqui, and more, is seated on the savannas which descend from the Volcano and the Monte Frio, and is bounded by the rivers which rise in their gorges and convey to the sea the tor-

rents of rain that almost incessantly during the winter season inundate their sides. The particular savanna which emerges from the important depression above referred to, and forms a sort of bed between the lofty and rugged sides of the mountains it separates, is divided lengthwise by two gullies or "barrancos," so wide and deep, and with such precipitous sides, that they may be properly termed cañons. In the one which bounds the savanna on the east flows the river Caldera, and in the other the Cochea, both of which head in the Volcano, and take such a course as to lead round the western slopes of the "Monte Frio," and enter the river Chiriqui Grande, which receives the waters of the eastern slope of that mountain. It was on this savanna that my route lay, after it had coasted around the Monte Frio to the east, following the valley of the Chiriqui until it reached and crossed its affluent, the Caldera, when it turned square to the right to follow up between the latter river and the Cochea; and by this savanna, if at all, the route for the railroad must debouch from the mountains.

Of the region intervening between the harbor of Golfito and the savanna country, and separated from it by the river Chiriqui Viejo, (which is the eastern boundary claimed by Costa Rica,) I could get no reliable information at this time, but may take this opportunity of describing it according to the results of my subsequent examination. It consists of a widely extended flat district, extending, to the westward from the boundary mentioned, to the Coto river, which flows into the Golfo Dulce, and bounded on the south for half its extent by a range of mountains, which jutting into the sea form the promontory of Burica and the Puertadel Banco, which is the cape on the right of the entrance of Golfo Dulce itself; from the latter the "flat" is separated by a narrow strip of sand beach. It is intersected by the Coto, Pavon, and Colorado rivers, the two former of which flow into the Golfo Dulce, and the latter into the Chiriqui Viejo; the divide, which is almost imperceptible, being due to the rise of the land towards the coast range of mountains already mentioned. At the season when I traversed the country, which was said to be an unusually bad one, considered in comparison with the ordinary rainy seasons, much of it was overflowed, and there were many "slews" or "bayous" of running water; but it is unnecessary here to anticipate the detailed description of this part of the country that will be given beyond, assisted by the map which accompanies this report. Enough has been said to explain the advantages of the plan I adopted for the survey of this region.

Several days were passed in acquiring information in regard to the field to be explored, instituting a series of barometrical observations, and in prosecuting the instrumental survey of the cañon with a view of determining the best place for a road to leave it and emerge on the savanna.

During this time I formed my plan for conducting the survey, and waited for the arrival of Mr. Wilson to put it in execution.

The circumstances of the case were as follows: Two months only were disposable for the entire survey; the time being limited, not only by the necessity of preparing the report of the commission for the information of Congress, but by the small amount appropriated for it,

which would not pay the salaries of the surveyors beyond that period. The quantity of work to be done was very considerable. The cañon and the savanna had to be surveyed with instruments, and the pass in the mountains, and the region between it and the lagoon, both explored and surveyed. The country between the Golfito and the cañon (of which I received such contradictory accounts that I suspected, and it turned out rightly, that nothing was known of its character) required exploration, and at least a topographical survey. There was not time to take the whole party across to the Golfito, and, returning thence to the cañon, continue the survey to the lagoon. The only method that promised success consisted in dividing the party and assigning to each portion a half of the line, so that the operations on the two slopes should progress simultaneously. As it was my duty to go over the whole line, it was necessary for me to take charge of the exploration on the Pacific side, which would enable me on my return route to revise the survey of the other division. I resolved, therefore, to put Mr. Wilson in charge of the Atlantic division of the survey, giving him the assistance of all the party except Mr. Jekyll, whom, on account of his abilities as a topographer, I selected as likely to be most serviceable as my assistant in the exploration towards Golfito.

Mr. Wilson arrived on the 13th of September. On the same evening I placed in the hands of his commissary the amount estimated by him to be necessary to carry the party down to the lagoon, and gave him and Mr. Wilson, respectively, letters of instructions for their guidance during my absence; copies of those letters are appended.

I left the party on the 14th, accompanied by Mr. Jekyll and an American, Mr. M. T. Tully, whom I had enlisted at Caldera, intending to employ him as chainman, but who subsequently acted as my commissary, relieving me of considerable trouble that would otherwise have interfered with the duties of a surveyor, which I assumed on leaving the party. We rode that day to the town of David, crossing the rivers Cochea, David, and Majagua. I remained for two days at David, procuring provisions, and forming a party of six natives. From David we went, by the way of Alauje, to a point on the Rio Chico called Carabasal. These three days' marches were the only ones we performed on the isthmus otherwise than on foot.

My plan was to proceed by the quickest, viz: the coast road, to Golfito, and return thence towards the cañon across the country. I had a draft on the purser of the vessel which should convey Lieutenant Jeffers to Golfito, and for the purpose of cashing it, as well as in order to confer with Lieutenant Jeffers in regard to that terminus of the line, I deemed it best to reach the Golfito at once. A still stronger cause of my desire to do so was the apprehension that if I should start from the Chiriqui Viejo, and undertake to penetrate from thence the difficult country west of that river, the natives might become dissatisfied with their engagement.

I was informed (correctly) that the river Coto, which had to be crossed before I reached Golfito, was so wide and deep that I required a canoe to cross it; and therefore hired one, with a crew of five men, at Carabasal, to go there and wait for me, and at the same time transport thither my supplies, which I could carry on horseback no

further than the mouth of the Chiriqui Viejo, for want of forage beyond that point. I also utilized the canoe by making it carry myself and two companions and three natives across the bay that is comprised between the promontory of Burica and the coast of the province, thereby avoiding several difficult river crossings, among them that of the Chiriqui Viejo. Three natives of my party, for whom there was not room in the canoe, reached the rendezvous I appointed with them on Burica, by keeping along the coast on foot. I left Carabasal on the 20th, in the canoe, expecting that half a day would suffice to carry the canoe to the rendezvous; but contrary winds kept us four days and three nights in her, not arriving before the 23d at Puerto Valsa; this is a cove formed by a reef of rocks projecting from the eastern coast of the promontory of Burica.

The provisions, on being got out of the canoe, were found wet and mostly spoiled with salt water, which had penetrated through the hides in which they had been packed. Taking a week's supply, the rest of the provisions were repacked in the canoe, which I appointed to meet me on the near bank of the Coto, sending one of my men in her. From Puerta Valsa we marched around Punta Burica, the end of the promontory, travelling over a beach of stratified rock, curiously marked with veins of quartz, and having a dip of 30° to the southward. The end of the promontory is not high near the coast, but towards the axis of it rises an isolated ridge, and still further towards the main land it rises into high hills, which come down to the water's edge. Not far inside its of junction with the main land the hills of the promontory subside to the level of the low plain behind it. The beach is bounded by an almost impenetrable thicket, which obliged us to travel during the hours when it was left bare by the tide, which rose and fell some twelve feet. The cocoa-nut grows all along the line of coast from Puerta Valsa to Golfito.

The beach also abounded in all sorts of water fowls, while the trees which border it were the roost of flocks of macaws.

On the 25th we passed several huts occupied by natives, who had come, as is their custom during this season, to load their canoes with cocoa-nuts; they were natives of San Domingo, in Costa Rica, and were the only people I met between Chiriqui and Golfito. The same day we arrived at a rocky spur that projects into the sea; this is the first of a range of precipitous cliffs which form Points Platanal and Banco; it was necessary to go around them by cutting a path through the mountains of the interior of the promontory.

On the 27th we crossed the Rio Santa Clara, a mountain stream, and on the 28th the Pabon, recognizing them as those laid down in the positions so named in the map of Cordazzi. On the next day, the 29th, we arrived at the banks of the Coto river, which, at its mouth, is an estuary of considerable depth, and about half a mile wide. Since leaving the point of rocks at the mouth of the Rio Santa Clara, we had travelled over a narrow strip of sand beach, on the inside of which was a swamp as far as we could see; innumerable streams of fresh water issued from it and crossed the beach, giving the impression that we were passing a sort of delta, of which the mouths were very small owing to their number. As we approached

the mouth of the Coto the streams became less frequent, and for the last three miles there were none, and the water of the swamp was too brackish to drink, indicating that the latter emptied itself into the Coto, and that its level was not much above high tide. At the Coto I was rejoined by the canoe, in which the party crossed the river, and continued along the beach, which consists of the edge of a mangrove swamp, left bare by the receding tide. On arriving at the mouth of the Golfito, we turned in and followed along a long sand spit which projects into the harbor; arrived at its end we were met by the canoe and ferried across.

A description of the Golfito requires some preliminary remarks in relation to the whole northern side of the Golfo Dulce. The entrance of Golfo Dulce, or Sweet Gulf, so called from the quantity of fresh water that empties into it, is between Point Banco, on the promontory of Burica, and Cape Matapalo, the extremity of a high peninsula, between which and the main land the gulf is comprehended. The length of the gulf is about forty miles, and its width fifteen. Midway to its head from the entrance, and on the right, is the Golfito harbor, and opposite to this on the peninsula, is the village of Punta Arenitas or San Domingo. The general direction of the axis of the gulf, between the entrance and the line joining these points, is north, but from thence to the head it has a northwest course.

The river Esquinas, which rises in the Cordilleras, and is navigable for a considerable distance, enters the gulf near its head; as it approaches the latter it flows around the western base of a lofty mountain, which is the first of a range that borders the gulf as far towards its mouth as the Rio Coto. A higher range rises between this one and the interior, and in a chasm between the two lies the harbor of Golfito, which resembles a mountain lake. Beyond, or to the eastward of the gap in the coast range by which the harbor is entered, the mountains begin again with a high peak, or single ridge parallel to the shore line, and then tend inland, dwindling gradually into the low hills as they leave the coast. The Coto river follows the eastern base of these hills, and the river Golfito (which empties into the harbor at its inmost recess, furthest from the coast and from the entrance) their western base, its valley lying between them and the continuation of the inner ridge which bounds the harbor on the north or inner side.

As one enters Golfo Dulce, he passes on his right the promontory of Burica, and will notice a remarkable ridge of half a dozen low hills rising along its axis at a short distance inside of its extremity, Point Burica, which is a low table land, with a low island in its prolongation. At the junction of the promontory with the main land at Point Banco, it rises into mountains, which decline both ways towards Point Burica, and towards the interior of the country, disappearing in the table lands of the former, and, at no great distance inland, in the low plains or flats of the latter. The slope of the ridge from Punta Banco towards the interior cannot be made out from a vessel until she is within the gulf, and has left that point a little behind.

When that is the case, she is abreast of a wide flat, which seems to extend far up into the country. The hills which constitute the pro-

longation inland of the promontory rise between these low lands and the plains of Chiriqui. They, however, extend but a short distance towards the interior, and north of the point where they terminate nothing separates the flats from the savannas but the river Chiriqui Viejo, which rises in the ravines of the northwestern slope of the volcano, and, coasting around the western base of the savannas, enters the ocean to the east of Burica. The western boundary of the flat is the range of hills that has already been mentioned as being the dividing ridge between the Golfito and Coto rivers, descending to the coast between them, and then bordering the gulf to its head at the Esquinas river.

If a sufficient description has been given of the northern side of the gulf, and of the relative situations of its most salient features, it is proper to enter into some details in regard to its most important point.

To the right of the entrance of the Golfito is the peak or isolated ridge, which has been referred to as the point where the range of hills that borders the coast thus far from the head of the gulf turns inland. It is not only separated from the hills to its left by the gap which affords the entrance, but also from those on its right, or nearly so, being connected with them only by the mangrove swamp which I have mentioned as having been coasted by my party on the day we marched from the Coto to the Golfito.

This peak, which forms a prominent land mark, and whose shelter makes the Golfito the quiet harbor it is, I named in honor of the Secretary of War. A long narrow strip of sand beach sets off at a tangent to its base on the right of the entrance, and extends one and a half mile into the harbor on a line parallel to and three-fourths of a mile from its shore on the left, until it nearly reaches the base of the mountain, which appears directly in front as you go in. Having arrived opposite the end of this hook or key, you turn square to the right in a channel half a mile wide, and enter the inner harbor, which may be seen over the beach, which is very low, immediately after opening the inner slope of Floyd Peak.

This inner harbor is four miles in extent by a mile in average width, and its general direction is parallel to the coast of the gulf. Its shore line is extremely irregular. At the bases of the mountains and hills are generally found flats overgrown with mangroves, which are covered with water at high tide; at some points, however, the rocks rise directly from the harbor, and form a bold shore. The depth of the harbor decreases towards its head, the mouth of the Golfito river, where it is extremely shallow, the mud being barely covered at low tide. This is due to the alluvium brought down by the river in its floods, which are of almost daily occurrence in the rainy season. The mouth of that river is hidden by mangrove islands; it lies at the inmost recess of the harbor to the east of a peculiar steep knoll which rises singly from the flats. Another smaller river, the Cañosal, empties into the harbor at its western extremity, diagonally opposite to the end of the sand spit; it has a similar mouth to the Golfito.

On the left of the entrance of the harbor, the hills rise sharply out of the water, but just behind the headland there is a fine, dry, level spot, with a clear, sandy beach, that extends nearly as far as the

mouth of the Cañosal. On it is a house, occupied by an Indian and his family, the only people that live in the country west of Chiriqui Viejo. This spot has been cultivated, and produces the greatest variety of fruits and esculents, together with coffee, chocolate, and spices. It affords a beautiful site for a village or town. Floyd's Peak, on the right of the entrance, and the sand spit which juts from it, likewise present favorable spots, with a little improvement, for settlements, and seem to be the most advantageous seat for such depots, arsenals, military and naval stations, and fortifications as the government may see fit to locate on this harbor. It may be fortified in the strongest manner by a system of redoubts encircling it, armed with heavy guns, connected by low field works, and commanded by two or three batteries seated on its crest. It commands the offing, and from it can be reached every point of the harbor, and of the entrance to it. The defences, if they enclose the depots, &c., above mentioned, would not only protect them from capture, but be themselves strengthened and enabled to hold out against the most protracted siege by the munitions and operatives they would contain in addition to the regular garrison and stores of the fortifications proper.

The commercial terminus of the road must be located upon the inner or main land shore of the harbor, where there is a space of some three miles in length, which is extremely well adapted for wharfage, the water being four fathoms deep, and more (according to Lieutenant Jeffers's soundings) within a short distance of the shore. This point can be reached by a pile bridge across the head of the harbor, at the narrow part into which the river Golfito empties, the line having to reach the crossing place, curved around the end of the coast hills, along their junction with the swamp which connects them with Floyd Peak, thus penetrating into the harbor without departing from the level grade on which the last twenty-one miles of track (as will be seen beyond) can be laid.

Appended to this report are several views of the Golfito, taken by me from points at which its chief characteristics are best seen. After a glance over them, the topographical chart of the harbor, which is also appended, will be found to be sufficiently clear.

While at the Golfito I questioned the owner of the rancho as to the nature of the country between that place and the Chiriqui Viejo. He told me (and his assertions were subsequently confirmed by information I got at Boqueron, in Chiriqui, and partly by my own experience) that to the east of the range, between the Coto and Golfito rivers, was a great flat, intersected by the Coto and many streams and bayous which flow into or are connected with it. He represented that country as impassable, and advised me to avoid it by following the hills to the northward until I reached the spurs of the Cordilleras, where I would meet with a picadura that leads from Terraba, in Costa Rica, to the river Chiriqui Viejo, and thence to Bogaba, in the province of Chiriqui. He described the route in question, which is occasionally used by the Terraba Indians in summer to trade with those of Chiriqui, as being a mountain path which offered no extraordinary difficulties, crossing all the rivers near their head except the last, the Chiriqui Viejo, which he doubted our ability to cross during the then

wet season. He stated, in answer to my inquiries about the Coto, that it was not possible to navigate it far from its mouth, owing to the obstructions presented by fallen trees, which would have to be cut away with axes to enable a canoe to ascend.

I did not decide as to the direction of my exploration until after leaving the Golfito. Had the ship I expected to meet arrived there during my stay, I calculated to draw on the purser for money, on Captain Engle's draft, to hire a bongo from Punta Arenitas to ascend the Coto as a preliminary operation, and to shape my subsequent course according to the appearance of the country; but no vessel arrived during the time consumed by me in the survey of the harbor. When that was concluded I deemed it to be my duty to leave it and continue the exploration. We remained four days at the rancho, during which time we surveyed the shores of the Golfito, partly on foot and partly in a canoe, took a series of barometrical readings, and made a reconnoissance across the hills lying between the Golfito and the valley of the Coto.

On the 7th of October we left the harbor and ascended the Golfito river about half a mile. For this distance the stream flows through a mangrove swamp, and is very swift and tortuous. After landing, we cut through a dense forest until we reached the edge of the flat, and then ascending a slight rise of ground encamped.

On the 8th we quitted the river and took a northeast course, which led us towards the divide between it and the Coto, and after crossing several low hills reached a swamp, which, every indication went to show, shed its waters into the latter. I now had to decide on my general plan of exploration. By skirting the edge of the swamp I might reach the foot of the mountains, which bound the low ground on the north, and, continuing along their base, could reasonably expect to reach the province of Chiriqui without encountering great difficulties. On the other hand, it seemed to be my duty to explore the most direct line for the road, and to qualify myself to state positively whether it would answer. If it would, there was a point gained by the exploration, since Captains Columb  l and Lallier, of the French commission of 1851, reported the swamp "impenetrable;" if not, there could be no doubt that by hugging the base of the mountains the road might be brought around by the north. I therefore resolved to take a course east by north, and pursue it, without deviation, as far as the Chiriqui Viejo, opposite to San Miguel. Our progress was very slow, owing to the difficulties of wading and the quantity of cutting required by the vines, canes, reeds, "pita" or mock pineapple, &c. The general course of the running water, both on the flats and in the bayous or rivers that we crossed, seemed to indicate that the longest dimension of the swamp was in a southeast course, and that by taking a northeast one, and crossing the current at right angles, we could sooner quit it; and as such a course did not conflict with the main design of exploring it, we took the new direction, therefore, and pursued it. The level of the swamp continually grew lower and the bayous more rapid and deeper.

On the 13th the difficulties became insuperable to proceeding with baggage, and I caused the Indians to put down their packs and keep

on the course. My reckoning assured me that I must be near to the river Chiriqui Viejo,* and there was every probability that bordering that river would be found a strip of ground a little above the general level of the country, as had been the case at the two rivers we had already crossed. There was also a peculiar appearance in the light through the tops of the trees ahead, which indicated that a broad river was not far off; but the swamp became altogether impassable before I could reach its banks, and I was obliged to come to a full stop. I then concluded to try whether we were in the vicinity of the hills of Burica on the right, or those which descend from the Cordilleras on the left, and on which the picadura from Terraba is located. It was impossible to get a sight of either, even by climbing the trees; the height of the latter and their thick foliage completely shut out from us in the horizon, and we could not see through them beyond a hundred yards at any time. Mr. Jekyll, with two men, explored in a due north course, with directions to proceed as far as practicable, and I took an easterly one with two others. I found the bayous equally numerous and deep in that direction, and Mr. Jekyll returned to the rendezvous, after a most fatiguing march, without finding any different country.

I came to the conclusion, from this day's operations, that we had got into the lowest part of the swamp, viz: that immediately bordering the Chiriqui Viejo, and that the last river we had crossed was its affluent to the Colorado; while the two streams previously crossed and the running water between them probably formed the Rio Coto; the river Pabon being most likely a bayou from the latter, which, in my opinion, empties by this as well as by other smaller mouths into the gulf. The volume of running water we had crossed before arriving at the Colorado was fully equal, as near as I can judge, to the aggregate of all the streams we had passed between the Rio Clara and the Coto, including the latter; the water was clear, in both cases alike; and when subsequently we crossed the Chiriqui Viejo, we found its water turbid and red, like that of the last river crossed by us in the swamp, which a Terraba Indian, whom I met subsequently at Boqueron, told me was the affluent of the Chiriqui, laid down in Cordazzi's map under the name of Colorado (or red) river.

My object of exploring the swamp having been accomplished, my time now had better be devoted to continuing the exploration from the other side of the Chiriqui Viejo to the cañon, since there was not left enough time to coast around the swamp to the northward by the Terraba route. We commenced our return accordingly on the 14th, and following the path we had cut in the advance, arrived in three days at Golfito. On arriving at the Rio Golfito we were met by two canoes from the rancho, brought there by two men whom I had despatched to precede the party and reach the rancho by coasting around the edge of the harbor. One of them was upset on the trip down, and much of our baggage was lost.

At the rancho I had the pleasure of meeting Lieutenant Jeffers,

* The distance travelled exceeded that of a direct course to the river considerably; but our path lay, for the reason above given, obliquely to its general direction.

who had landed that day from the Panama steamship Guatemala, (the St. Mary's being detained at Panama by the state of affairs there,) with one assistant, Mr. — Towers, naval engineer, and a party of sailors.

Lieutenant Jeffers shared his provisions with us to the fullest extent that was consistent with his duty to his command, and lent me \$100 out of his private funds.

The next day but one, October 19, he took my party in his launch across the gulf to Punta Arenitas, and left us there. I take pleasure in expressing my sense of great obligations to him for the cordial and liberal manner in which he rendered me assistance, and afforded me facilities to continue my work.

Punta Arenitas is a village of some 180 souls, located on the beach of the gulf opposite to Golfito. It has a shallow harbor, formed by a long key of sand that projects from the coast eastward of it, and hooks around so as to form a rather deep bight.

Two streams empty into the gulf at Punta Arenitas, the San Domingo and Platanales. On the banks of the latter is a wilderness of plantain and banana trees, in which a person might very easily get lost. Good pasture is found a short distance inland, and some cattle are raised on it, and every tropical production grows with the least culture. The town was originally built by a French colony, (who were attracted by the pearl fishery,) on the sand spit, where fresh water can be obtained by digging; but it was washed away and destroyed by an earthquake some eight years ago, after which such of the colony as remained preferred living on the beach, although it was not so healthy a location, on account of the swamps in the vicinity.

The population is Indian, with some negro, and an admixture of white blood. Two or three Italians who have married native women reside there. The governor of Golfo Dulce (which comprises, according to the claims of Costa Rica, all the country as far east as a line drawn from Punta Burica across the isthmus tangent to Cape Valiente, on Chiriqui lagoon) is Don Antonio Morales. He lives at Tigrito, a town of some eighty souls, six or seven miles further up the gulf, at the mouth of a little river of that name some fifteen miles in length; its mouth is obstructed by a long sand-bar similar to that of Punta Arenitas, but not visible above the surface. The banks of the river are a mangrove swamp for as high up as the town.

The governor received me with courtesy, and expressed hopes for the success of the road. At Tigrito I purchased some supplies that my party required, and which could not be got at Punta Arenitas.

On the 20th, the day succeeding my arrival at the latter place, I left it in a canoe, or bongo, such as are used to carry loads of cocoanuts from the coast of the gulf to Panama.

At daybreak on the 22d we were near the mouth of the gulf, and I took panoramic sketches of the coast, from Punta del Banco, around the peninsula of Burica to our landing place; (these I afterwards continued from points that gave good side views of the latter to its origin in the plains.)

These sketches, with one that was taken at Punta Arenitas, both by myself and Mr. Jekyll, of the coast range between the Coto and

the Esquinas, give, when joined, a complete panorama of the whole of Golfo Dulce and the promontory of Burica. Continuing on our course with the northwest wind, which prevails on this coast half the year, we passed around Punta Burica, and along the eastern side of the promontory of that name, and reached a place called Guanabano, a slight indentation in the coast, sheltered by reefs and sand bars, and marched at once to the pueblo San Bartolomé, a village of four houses on the coast; we crossed the Quebrada Linanani, which descends from the hills of Burica, and the river San Bartolomé, which appears to be the line of demarcation between the hills and the plains from which they rise, and reached the pueblo some time after nightfall.

It is worthy of notice that there is a spot on the eastern side of the promontory of Burica which would be very advantageous as a terminus of the road. It is the cove of Charca Azul. I do not find it laid down on the charts, and it is not laid down on Cardazzi's map as a port, but simply as a small pueblo, (there are but two houses there.) I sailed into the harbor, which was not out of my way to Guanabano, and took a sketch of it, which is appended to this report. The harbor is an indentation in the shore, which seems to be protected by a reef of rocks from south winds, but is open to southeasterly ones. It is exceedingly deep and the shore so bold that I was assured, and believe from its appearance, that a ship could lie alongside the rocks. A stream of fresh water descends from it into a ravine in the hills. The whole appearance of the spot is very fine.

The distance from Charca Azul to the pass is at least five miles less by the route a road must take, than from Golfito, and may be more, depending on the circuit that must be taken around the flats. Only one formidable river intervenes, and but a small share of the flat lands that are liable to overflow. If a breakwater could be built that would render it a safe harbor in all winds, it may be found a suitable terminus.

I may here mention that in marching around Point Burica, and afterwards sailing around the island which lies off it, I had ample opportunity of examining the strait comprehended between them, which had been reported as constituting a fine harbor; but the reverse of this proved to be the case, as the rollers broke throughout the strait on very dangerous points of rock. Beyond San Bartolomé on the coast is the mouth of the river Maijaqual, a bayou or delta-mouth of the Chiriqui Viejo. The coast is a narrow sand beach, with bayous, low land, and swamp in the interior; its character had been the same since leaving the Quebrada Linanani. The Chiriqui Viejo is a large, swift river, with muddy bed and banks, and was swollen so as to spread over the latter when I passed it. It is very crooked, and flows through a low, flat country to the coast. It seemed to me that this river marks the intersection of the slope of the savannas which decline in every direction (as the streams indicate) from the volcano, with the flats that have been formed by alluvial deposits between it and the Golfito river; and I may be permitted to venture this theory in relation to the latter, that they are underlaid at no great depth by a continuation of the lava field that begins to appear at the water's edge, and rises to the base of the volcano. This theory would account for

the ground being generally tolerably firm under foot, or at least presenting no quagmires, and would indicate that the construction of an embankment, with proper culverts and bridges across the flats, would not be a very difficult matter.

We embarked on the Chiriqui at a point a mile above its mouth, and descended it to the mouth of the Piedra river, which flows into it just before it reaches the ocean. We ascended the Piedra some distance, and landed near the pueblo of Cantagalla.

I sent ahead from the Chiriqui Viejo a runner to the hacienda of Don Lorenzo Gallego, at the cañon, appointing Solano as the place where he should meet me; he was to bring me information in regard to Mr. Wilson's party. It was my intention, as I have before mentioned, to survey back from Solano, or San Miguel, to the Chiriqui Viejo, which lies perhaps ten miles from it to the westward, but prior to setting out in that direction I wished to get news from my party.

The country between Cantagalla and Cochea offers the most exquisite landscapes. The eye is refreshed with a varied succession of green savannas, fringed and dotted with groves and clumps of magnificent trees of every description, from the wide-spreading beech to the slender and graceful palm, and intersected by an infinity of clear, swift, pebbly brooks. The herds of horses and cattle and the palm-thatched huts of the natives scattered over the scene gave it at once an air of life and tranquillity. A characteristic sketch of this savanna is appended.

The route to Solano crosses the Piedra, which at that point is a violent river, with low strong banks and a bed of large boulders. It divides into several channels, and it requires considerable time and pains to pass it without accident. It sometimes rises at very short notice, and persons are said to have been drowned in the further arms after crossing the first without difficulty.

The town of Bogaba, which is seated on a very flat and wet savanna, was next passed, and we then arrived at Solano. Our crossings of the Piedra informed me as to the practicability of crossing it by a bridge. We found it at nearly its highest stage, and it is said to be, in summer, a small stream. The numerous islands in its bed, and the firm rocky character of the latter, and of the banks, assure the foundations of piers and abutments. Just above Solano, and near the hacienda of Don Pedro Martinez Candiner, it passes through a narrow channel, and may be crossed by a single span.

At Solano I received news of my party, whom I had left at the cañon. My runner returned with the intelligence that they had gone about eight miles up the cañon, beyond the hacienda of Don Lorenzo, and had then returned to the ship at Fish creek, where they arrived on the 2d October. He had inquired at the hacienda for letters that might be there for me, but was told that none had been left.

The intelligence that the chief part of the duty I had been charged with remained unfulfilled obliged me to give up the idea of surveying back to the Chiriqui Viejo. The few miles of savanna which intervened might indeed be surveyed in four or five days, going there and returning; but that time might be invaluable, and turned out to be so, in the mountains. I considered that I should devote all my time

and resources from this time forward to the great object of seeking for the pass, and surveying, as well as my means would allow, between it and the lagoon. I trust, therefore, that the hiatus of some ten miles that will be observed in the plat of my survey will be excused.

The survey of the Chiriqui being thus given up, we retraced our steps to Bogaba, and set off thence in an easterly direction, *via* Boqueron and Dolega, to Cochea. In this march we crossed the Piedra again, the Rio David, and the Rio Cochea, together with seven or eight minor rivers, and an infinity of brooks, all of which, and especially the Rio David, were swelled to overflowing by the violent rains which fell during the march.

At Dolega I was hospitably entertained by Don M. Gallegos, judge of the supreme court of New Granada, who had just been appointed prefect of the province. At the Cochea river I met a runner with a letter for me from the commander of the expedition, confirming the account of Mr. Wilson's party.

We stopped here three days drying meat, and occupied the time in surveying the country in advance, along the brink of the cañon in which the Cochea flows towards the "initial point;" so that when all the preparations were complete for a two weeks' sojourn in the mountains, we were enabled to proceed in a single march to the latter point, which, it will be remembered, was at the hacienda of Don Lorenzo, at the Caldera cañon. We continued up that cañon, crossing the river (which at that season is swollen and very impetuous) several times. About station No. 9 it seems to run in a zigzag line across the cañon, impinging against bluffs and walls of trap and basaltic rock on the one side, leaving a comparatively level border on the other. The direction of the cañon, as we ascended it, seemed to change for the worse relatively to the volcano, heading more towards its peaks; and the sides of the mountains, on the other hand, to overhang it more and more, and at greater altitudes. The slope of the stream also increasing rapidly, indicated that we were rather ascending towards a sharp divide, or to a ravine in the volcano, such as we had seen the Cochea cañon terminate in, than towards the Pass swamp or lake we had expected to find. The fact that the volume of the river did not diminish as rapidly as it ought, supposing that this, its main branch, drew its supply only from the area to the southward of the divide, or general ridge of the Cordilleras, led me to believe that it must drain a large part of the northern slope of the volcano, which could only be by its heading up into that side, turning more to the westward, and avoiding the general ridge, which would, under that supposition, remain to the northward of it; that the cañon was heading up was also indicated by the gradual narrowing together of its sides, which promised soon to be so close as to leave a mere chasm or mountain gorge not larger than would give egress to the stream.

These observations, which I was better prepared to make, for the reason that I was on the watch for such difficulties as must have been encountered by Mr. Wilson's party, brought me to the conclusion that he had pursued the cañon up to its head, and found it terminated in the mountains.

When I left Solano it was with the expressed intention of exploring the mountains for a pass and cutting a road down to the lagoon; and

as it appeared that the reports I had then received were true as far as the fact of no pass being discovered in the direction of the cañon, and the party having returned without further search, were concerned, it became my duty to set about it.

I caused four lines to be explored in radiating directions from a point of the cañon $6\frac{3}{4}$ miles from the initial point. Mr. Jekyll followed up the survey line of the party to within $2\frac{1}{8}$ miles of its termination, according to the account since rendered by Mr. Wilson. I pursued a line at right angle, with it leading directly up the side of the cañon, and found it, after a short ascent of 45° , to rise into a nearly perpendicular cliff of some 500 feet in height; from its top I obtained a fine view of the eastern side of the volcano; a bluff projected from it at a point about where I had turned off into the cañon, and on its upper side appeared to be a fork of the river coming down from the very peaks of the mountain. A belt or zone of savanna appeared to descend the sides of the latter just below the bluff, and to be continuous from thence to the savanna of Don Lorenzo; of this, I was informed, the native hunters sometimes take advantage to reach the upper parts of the cañon in pursuit of game. The paths followed by the two other exploring parties were intermediate to those described; they led directly towards the peaks of Monte Horqueta, of which the latter had skirted the base. One led up a ravine, and one a spur, which, if they did not have their origin in the heights of the mountain, led at least directly towards it.

It was my expectation to find a fork of the Caldera which should rise to the right of the cañon, and that such fork would lead to a depression. It seemed, however, (as no such fork appeared, unless it was one we passed early that day, which, falling into a cascade, looked unpromising,) to be equally advantageous to seek the main ridge at once, and prospect directly along it for a low summit. The peaks of Horqueta, which rise sharply out of the ridges of the axis of the main chain, would offer a fine opportunity of observing the topography for a considerable distance around, and a single glance from its top would at once clear up the cause of the return of the party, and might indicate a course that would lead to a favorable pass, and save several days' marching, since, once in the forest, the features of the surrounding country are shut out from view by the denseness of the foliage.

Accordingly, on November 15, we started up the ridge that was explored the day before, leaving the cañon and small ravine to our left. After attaining its highest point, the altitude of which was obtained, we descended, and ascended again, crossing several ridges, until we arrived at the foot of Monte Horqueta, whose side we ascended to an altitude of about 7,000 feet, and encamped. At this altitude everything indicated constant rain or fog. The trees were covered with long dripping mosses; the fallen trunks which obstructed our way were water-soaked and rotten. All sorts of vines, parasites, and fungous growths encumbered the forest. The thermometer was 56° Fahrenheit.

The next morning Mr. Jekyll and myself, accompanied by two Indians as picadores, ascended to the summit, leaving the rest in

camp. At first the whole surrounding atmosphere was thick with fog, and nothing could be seen in any direction; but at about 11 a. m. the sky cleared, and a most magnificent prospect repaid us for the trouble of the ascent. That others had been there before us was evident, from the fact of the trees being all cut down on the summit, so that an unobstructed view could be had towards every quarter of the compass. This had been done by Mr. Shepherd, who ascended the peak some years ago.

Looking southwards, the province of Chiriqui lay spread out beneath us like a chart. On the right arose the volcano, which seemed to cover more ground than all the savanna country, and appeared infinitely grander and even higher than from the plains, although now contemplated from an altitude of near 8,000 feet. Its sides at this near view were inexpressibly wild and rugged. They seemed an inextricably confused pile of cones and ridges, cleft transversely by several tremendous chasms, and furrowed into ravines and gorges by foaming torrents, which seem every moment to gather fresh strength. The forest grows to the summits of the highest peaks. The foliage, as seen through the damp air, and illuminated by a vertical sun, gave a decided purple color to the mountain, and greatly enhanced the beauty of the picture. Around the base of the volcano, and comprehended between it and the mountains we had ascended, wound the cañon. In its shadows we could occasionally discern the flashing waters of the Caldera, while the two ravines into which it forks were plainly seen heading up into the heart of the volcano. The western or further brink of the cañon appeared, as far up as the first fork, to have a border of savanna land, which, like it, wound like a spiral around and up the slope of the volcano with a greater inclination, and growing rougher and more broken by ravines as it ascended. This belt or zone of savanna was partly covered with trees and partly with grass. On the left—that is, on the near side of the cañon, and crossing diagonally the line of march that we had followed, between the point we left it and the summit we were on—we saw three ridges, each capped by several cones, so that the whole resembled at first a confusion of lower peaks.

Bounding the view to the left, or to the westward, was a spur of the great ridge. It took a nearly south course, and terminated abruptly just above the Santa Maria plateau, already mentioned, which lies at its foot on the eastern slope. The cañon, just above that point, had been observed during our survey to take a semicircular bend or hook, which it now appeared was around the base of the last hill of the spur.

Between this spur and the Monte Horqueta, our stand-point, and the triple range of hills in front of it, lay a continuous, straight, and spacious valley, which rose from the brink of the cañon near the point where my reconnaissance of September 5 terminated, referred to beyond as barometrical station No. 9. The head of this valley seemed at first to be walled up by a continuation of the main ridge; but a light mist forming for a moment across it, and serving to relieve the spurs of the mountains one against the other, we discerned a pass by which it was connected with the Atlantic slope. The main chain

seemed to be split diagonally immediately after it sends off the great spur to the southward, and to recommence in a ridge which passes close by the northern base of the Monte Horqueta and loses itself in the volcano. This ridge also continues eastward beyond the pass, in a direction parallel to the great ridge, but gradually declining until it reaches the valley of the Culebra.

Beyond this ridge was a second one, indicating the valley of another and larger tributary of that river. Following its grayish blue side with the eye to the eastward, it was seen to terminate in front of a tremendous spur of the Monte Frio, which evidently formed the divide between the Culebra and the Guaromo and Robalo valleys and its side, which looked purple through the mist, the eastern slope of the valley of the former.

On the same day we descended the mountain to near its base, and on the next crossed the valley obliquely to the northeast. We found it broad, flat, and swampy, greatly obstructed, and almost dark from the luxuriance of smaller growths of all kinds. In it there were no signs of any former travellers; and, as the mark of the machete remains on the trees and undergrowth for thirty years and more, it is probable the valley was not discovered, or at least explored before. On finding a rill running to the northward and eastward, we pursued it down to a large branch of the Culebra, which we followed to where it joins the latter. From this point we took across the divide to the eastward, which separates the Culebra valley from that of the Robalo, reaching that river at a place called the "Tres Brazos," or Three Forks, which is well known to the hunters of Fish creek. From this we went to the mouth of Frenchman's creek, skirting the base of the hills along the edge of the flat lands that border the lagoon, arriving on November 13, on which date I reported to you.

Proposed location of the railroad.

Beginning (for convenience of description) at the initial point, near the hacienda of Don Lorenzo, on the Alto Boquete, the line should ascend towards the summit upon the zone of savanna that has been described as bordering the cañon on its western side, until it passes the point before referred to as barometrical station No. 9, and arrives at an open spot opposite to a stream which falls in a cascade into the Caldera from the other brink of the cañon. At this point, where the cañon is narrow with bluff sides, the line crosses over it and attains the foot of the valley drained by the stream; it follows up the eastern side of the valley, which is the western slope of the great spur before mentioned, until it reaches the swamp at its head, traverses the latter, and meeting with a rivulet which takes its rise in it and flows northeasterly, follows it down to the Culebra, and reaching the forks of the latter, takes one of the directions that will be hereafter discussed, viz: down the valley of the Culebra to its mouth; or to the mouth of the Robalo, crossing the divide between it and the Culebra; or to the mouth of Frenchman's creek, at that part of the Chiriqui lagoon called Toucey bay.

To continue the location towards the Pacific, below the hacienda

of Don Lorenzo, the line follows down the savanna until it reaches the site selected for a bridge over the Cochea cañon, where it crosses the latter, and makes its way to the bridge site I have recommended on the Rio Piedra; thence it is directed to a point south of Boqueron, from which it goes to Solano, and thence to the river Chiriqui Viejo, which it must cross at a point lower than was reached by my survey, and about opposite Solano. From the crossing it takes a direct course across the flats to the point of hills which juts into them on their western side, whose base it follows to the shore of the gulf at the mouth of the Rio Coto, and enters the harbor of Golfito through the swampy depression between the range of hills and Floyd Peak, or by a deep cut or tunnel through the hills.

Curving around the base of the last hill on the edge of the swamp, if it enters the harbor through the depression, the road next crosses a narrow and shallow part of the harbor and gains the inner side of the latter at the base of the mountains which face the sea; almost anywhere along this base, from the point where the crossing is made, to one opposite the end of the sand spit, will answer for the terminus of the road. If the road can be shown by instrumental survey to be capable of being taken through the coast hills, it may come out from them on their inner side at the point where the mouth of the Golfito river is to be crossed.

INQUIRY INTO THE PRACTICABILITY OF THE ROAD.

I. Of the Pacific slope, between the Pass and the Golfito.

I have in my preliminary report stated my belief that the country offers no difficulties that cannot be overcome to the continuation and working of a railroad between the lagoon and Golfito. A demonstration of such opinion would involve inquiries into the economical and even the political aspects of the question. Considerable research of statistics would be required to ascertain what kinds of freight, and in what quantities, would be likely to prefer the transit route to the voyage around the Horn on their way to China, Japan, or the Pacific coast. Information on this head, more recent than was some years back collected for the use of Congress, would show what income the road could reasonably expect, and would be sufficient basis for an approximate estimate of the maximum amount that could be expended in its construction, viz: the limit beyond which the tolls would fail to compare in a paying proportion with the annual aggregate of the interest on the first cost of the road and rolling stock, the repairs, current expenses, &c.; but such inquiry not only demands time, but a person of experience in mercantile affairs to prosecute it.

The manner in which such a road, supposing it to be completed and its harbors fortified and garrisoned, would add to the defensive strength of the United States and increase the cohesion between its Pacific and eastern divisions; and the facilities for aggressive warfare in either hemisphere that it would afford them, and the general control over the entire western continent, which they would be in a position to acquire, are points which bear on the question of practicability;

their discussion, however, likewise demands a more competent investigator. I shall confine myself to an inquiry into the mechanical elements of the problem, premising that I owe to a publication by the eminent engineer Charles Ellet, jr.,* the general views on this subject which guided me in my examination of the country, and such information as is of an unusual and valuable character as I have had occasion to refer to beyond in support of my opinions in regard to the practicability of the grades recommended on both slopes of the line.†

The Pacific terminus of the road may be located on the inner side of the Golfo harbor, which offers an extent of three miles of wharfage, with suitable depth of water, viz: over four fathoms. From the terminus the road would cross the mouth of the Rio Golfo, and follow the base of the hills around the mangrove swamp, which separates them from Floyd Peak; it will continue to follow the eastern base of the range until it reaches the point where my survey line leaves them. All this portion of the line, which is about nineteen miles in length, is on a level. The most difficult part is that bordering the harbor, but it presents no extraordinary obstacles. The mouth of the river has a depth of about six feet of water, with sand bottom underlying the mud, which secures that a firm pile foundation can be made across it. The base of the hills will be found to offer a border of ground elevated above the level of overflows without a transverse slope so considerable as to render expensive side forming necessary. From the last-mentioned point to the Chiriqui Viejo, opposite to San Miguel, the distance in an air line is eight miles. The country is nearly on a dead level, and the ground, although overflowed in the rainy season, offers a firm enough foundation for an embankment of five or six feet in height, which, if provided sufficiently with culverts, and connected across the Colorado and Coto rivers by means of bridges, would probably form an efficient and durable road bed; or the flats might be crossed on a pile founda-

* The project which is now being discussed in France for crossing the Alps by the Simplon route, by a railroad, was no doubt suggested by the same work, from which are quoted the following paragraphs:

"We should not regard mountainous regions as necessarily excluded from participation in all the comforts and conveniences due to the railroad because they can only be reached by lines of very steep grade or very abrupt curvature. The American locomotive can penetrate into the most retired valleys of Switzerland and bring forth the products of their industry. Wherever men can go to cultivate the earth with profit, there the locomotive can follow to take away the produce of their toil."

"The Mountain Top track, which is scarcely known out of the State of Virginia, proves by its daily achievements that the Alps themselves may now be surmounted, without tunnelling, by the modern locomotive with its train."

† The following quotations from Captain McClellan's report will serve to show that there is nothing extraordinary in the project, which will be found submitted beyond, in respect to grades: "It is the opinion of many able railway engineers that, on a permanent track, grades of 200 feet, and even of 250 feet, may be advantageously overcome by locomotive power, it being clearly understood that such grades are to be resorted to only in cases of absolute necessity, economy in working the road rendering low gradients very desirable." * * "It is evidently the fact that there is at present a tendency to use much higher grades than were formerly considered practicable or advisable. Even in England and on the 'continent' the American system of cheap roads, with high grades, to avoid the great expense of long tunnels, deep cuts, and high embankments, appears to be, to a certain extent, rapidly rising in repute."

tion which would elevate the track above the natural surface sufficiently to guard it from overflow. There would be several bridges required in this division of the road: one of 120 feet span, two of 50 and 40 feet, and the rest of trifling size. Should the estimate of the construction of this part of the line prove heavy, there remains the resource of avoiding the low ground entirely by encircling it at its upper border. As, however, this plan would add very materially to the length of this division, it does not seem advisable to adopt it, except as a *temporary expedient, to be abandoned for the direct line whenever the funds of the party owning the road shall warrant the construction of the embankment or piling.*

A bridge of considerable span will be required to cross the Chiriqui Viejo; on the left or eastern bank of this river the savanna country is entered, and the road will proceed to Solano, a distance of ten miles, with an average natural ascent of 70 feet to the mile. On the survey line there is an ascent of 230 feet to the mile for the four miles between Solano and Boqueron, and a down grade of 83 feet per mile between the latter point and Dolega, where the line begins to rise again on the savanna between the Cochea and Caldera cañons. The railroad can probably, however, be located on a regular ascending grade of 59 feet per mile from Solano to the savanna included between the Cochea and Caldera cañons by taking a short circuit below or to the south of Boqueron, and then directing itself above Dolega, crossing the Rio David about three miles above that town, and crossing the Cochea and entering upon the savanna between that river and the Caldera, at the Cochea bridge site. From this point the savanna has a natural average ascent of 195 feet to the mile for $3\frac{1}{4}$ miles, viz: to the stone wall bounding Don Lorenzo's land, marked station 8 on the profile; between the latter point and the hacienda, another distance of $3\frac{1}{4}$ miles, (if the brink of the Caldera cañon is followed,) the rise is 262 feet per mile; from the hacienda the line will be laid along the continuation of the savanna at the base of the volcano, crossing a ravine in its course, a distance of $4\frac{1}{2}$ miles, when it arrives opposite the foot of the valley which descends on the opposite side of the Caldera cañon from the pass; the grade on this division is 142 feet per mile. It should be remarked that, as a higher level is reached on the savannas, they become more undulating and broken, and their declivity greater; the lesser grade on the last-mentioned part of the line being due to the fact of the savanna being crossed obliquely to its greatest slope, and rather in a transverse than longitudinal direction. There is, however, no doubt as to the practicability of laying a track on any part of the savannas, or in regard to the line reaching the Caldera crossing without any unusual difficulties; the steepness of the grade between station 8 and the hacienda cannot be avoided, on account of the savanna being confined within the two cañons so as to prevent a development of the line, but this grade is not higher than others which are equally necessitated beyond, and which, it will be seen, are to be regarded as not excessive or beyond the limits of advantageous working.

From the last-mentioned station the line has to be crossed over the Caldera cañon on a trestle-work viaduct; it then enters the valley

at whose head is the pass, and cannot ascend to the latter on an average grade less than that of the axis of the valley, which is 291 feet per mile, unless resort is had to some other expedient to gain length of line than any generally used in railroading. Winding up the summit on ordinary grades is almost precluded on account of the declivity, not only of Jekyll's river, which drains the valley, but of all the streams in the tract between the cañon and the summit, being greater than the limit of such grades. As this difficulty is met with in a much greater degree beyond the summit in the tract which is comprehended between the watershed and a line parallel to it, and about 12 miles from it, it will be well to discuss it in connexion with both these portions of the road. For the present it will suffice to state that the track on this, the upper $6\frac{1}{2}$ miles of the Pacific slope, can be located on a grade of not over 290 feet to the mile, and that such grade will conform to the higher grades on the other slope, so that the same engines and trains can be worked without changes over the contiguous portions of both slopes; and that, as it can be shown that such grade is within the limits of practicability and profitable working, there is no necessity for resorting to any expedients, much less unusual ones or of doubtful advantage, to gain length of line, in order to diminish the grade.

To sum up the above remarks on the Pacific slope, it may safely be assumed that it is perfectly practicable to connect the pass with the terminus at Golfito by an ordinary track which will admit of being worked with advantage by engines and rolling stock generally of such patterns as are at present in use.

II. *The Atlantic slope.*

There is a remarkable transition between the upper portion of the Pacific slope, which subsides in the pass to a dead level, and the contiguous part of the Atlantic slope. The stream which flows into Chiriqui lagoon out of the swamp at the summit descends at first with a declivity which averages 1,055 feet per mile, and meeting the chief branch of the Culebra continues down to the forks of that river with an average fall of 347 feet to the mile; the whole descent in seven and a quarter miles being 4,209 feet, or 580 feet per mile on an average, on the shortest natural valley line between the summit and the forks. In this tract of country it would probably be necessary, in order to locate a line of ordinary grade, say, not over 180 feet to the mile, to resort to the expedient which was originally, I believe, practiced by Mr. Latrobe on the temporary track first laid on the Baltimore and Ohio railroad, viz: of "*doubling*" the line on the sides of the valley. The chief difficulty of this plan lies at the turns, where it is proposed by European engineers to tunnel into the side slope on a sharp curve which shall bring out the track at a higher level than it entered. A better method, however, has been adopted in this country, viz: to construct a level switch at each turn, by means of which the train can be run off the grade, stopped and reversed, so as to run on the other grade with the engine in the rear until the next change of direction is made. There is some loss of time and power connected

with this arrangement of grades, and it is open to the objection that the doubles backward would occasion some ravines and spurs too thin and sharp to be curved around to be crossed twice, occasioning an extra number of bridges, viaducts, embankments with culverts and cuttings or short tunnels; the ends of level track would be likewise a cause of expense, for which there would be no necessity if the natural declivity were within the above-mentioned limit of grade. These difficulties are, however, simply in proportion to the number of doubles required to master the elevation; and where there is such a length of valley as is found in the present case, not many changes of direction will be required, and no excessive increase of aggregate cost occasioned by them.

I should, therefore, consider it within the limits of practicability to ascend from the Culebra forks to the summit by the ordinary railroad system; but for many reasons would prefer to make use of one which would adapt itself with more pliancy to the peculiarities of that region. I refer to a system which was suggested by a brochure written by Mr. Ellet, who also originated it practically in his celebrated provisional track over the Blue Ridge. It has since been ably treated by M. E. Flachat, a French engineer of repute, in his work entitled "*La Traversée des Alpes.*"

In brief, it employs grades as high as 300 feet to the mile, and curves with radii as small as 300 feet. A track laid on this principle can adapt itself readily to all the circumstances of topography that occur on the line I recommend; it remains to be proved that trains can be carried safely and speedily up and down such grades, and around such curves, and with such a proportion of useful or net load as would enable the road to pay its expenses.

Captain McClellan, in his report to the Secretary of War of November 21, 1854, gives the following formula for the maximum load (x) that an engine of given adhesive weight (A) (expressed in pounds) has adherence sufficient to draw up a grade of any given number (f) of feet per mile, the engine and rail being in good order.

$$x = \frac{0.2 A}{0.4242 f + 8} \dots \dots \dots (1)$$

The engines which are used on high grades have six driving-wheels, which bear all the weight, and consequently A , in the cases in which I shall apply the formula, is the entire weight of the engine. A thirty-ton engine, with six drivers, which is built to exert a force of traction at least equal to its adherence, has an adhesive weight of 67,200 pounds; substituting this number for A , and 300 for f , we have $99\frac{1}{2}$ tons for the load which such an engine can draw up a grade of 300 feet per mile. Of this, there must be allowed for the tender, with wood and water for twenty-five miles, (which is very nearly the length of the Atlantic portion of the route,) 2,9000 pounds, or about 13 tons, leaving $86\frac{1}{2}$ tons for freight cars and freight; dividing this in the proportion of 4,425 to 5,575, which is the ratio of the weight of the cars, (16,000 pounds,) to their capacity, (which averages 9 tons,) we have the net load or freight of over 48 tons.

The formula for the maximum load when the rail is "in bad order, wet, slippery, greasy," &c., is:

$$x = \frac{0143 A}{04242 f + 8} \dots \dots \dots (2)$$

Applying this to the same example, we have for the load that the thirty-ton engine can draw up grades of 300 feet a gross weight of 71 tons, or 58 tons of cars and freight. As a means of testing the accuracy of these formulas for high grades, let us compare their result with actual performances of engines on such grades. Take, for example, Mr. Ellet's road across the Blue Ridge, at Rock Fish Gap.*

The average grade on the western slope of the road is $223\frac{1}{10}$ feet per mile, and the maximum grade on the same $279\frac{8}{10}$ feet. On the eastern slope the average grade is $257\frac{4}{10}$ feet per mile, the maximum being $295\frac{6}{10}$ feet. The engines* weigh, with their fuel and water for eight miles, (which they carry without a tender,) 55,000 pounds, and being mounted on six wheels, all drivers, the whole of this is adhesive weight. According to formula (1) the gross load which they can draw up the steepest grade, viz: 296 feet, is about $82\frac{1}{2}$ tons; deducting the weight of the fuel and water, which will be about $2\frac{1}{2}$ tons, the remainder, 80 tons, will be the weight of the cars and freight. Formula (2) gives $58\frac{3}{4}$ tons in gross, or about $56\frac{1}{2}$ tons of cars and freight as the load that the engine can draw up the same grade, the rail being supposed in bad order, &c., which includes the case of its being wet with rain, fog, &c., the only causes of slipping on roads in Central America, where snow, sleet, ice, and frost never fall or form on the track. In conveying freight, the engines in question draw habitually three or four freight cars, weighing with their loads from 40 to 43 tons, and sometimes exceeding 50 tons. "With such trains," (says the chief engineer,) "the engines are stopped on the track, ascending or descending, and are started again on the steepest grades at the discretion of the engineer." He also remarks that he has never permitted the power of the engines on this mountain road to be fully tested, and that during a period of two and a half years that this road was in constant use the engines failed *but once* to make their regular trips, although the mountain was covered with deep snow, sleet, or ice, for weeks in succession, the cuts frequently filled for long periods many feet in depth with drifted snow, and in spite of every other impediment that inclement seasons have occasioned. In view of these performances of the engines in question, with loads within 10 per cent. of being equal to the load given by formula (2), it may safely be concluded that such formula may be relied upon in Chiriqui to give sufficiently accurate results, and that the loads deduced from it can be safely worked up to, and without any undue strain on the machinery.

If, therefore, engines of the same pattern and weight were employed they could draw—

- On grades of 300 feet, 57 tons— $31\frac{1}{4}$ tons net freight.
- On grades of 280 feet, 60 tons— $33\frac{1}{2}$ tons net freight.
- On grades of 260 feet, $64\frac{1}{4}$ tons—36 tons net freight.
- On grades of 250 feet, $66\frac{3}{4}$ tons— $37\frac{1}{4}$ tons net freight.

* See note E, Appendix.

It is evident that the formulas quoted merely express the mechanical law that the effort to move a weight up an inclined plane increases in proportion very nearly to the grade; the experimental or practical rules that a force of traction of eight pounds is required to move each ton of the train on a level, and that the limit of the traction that an engine can exert is from $\frac{1}{5}$ to $\frac{1}{10} \frac{4}{10} \frac{3}{10}$ of its weight, according to the condition of the rails.

In regard to the latter law, there is not as much certainty as for the two former. The nature of the property of adhesion, to which the resistance of the rail is due, does not seem to be understood. Without entering into an inquiry on this topic, it is sufficient to say that by using a broad flat rail the adherence of the driving-wheels may be materially increased. An example of this is found on a road in Pennsylvania, where there are two grades, the steepest of which is laid with a broader rail than usual. It has been discovered that a locomotive can draw a materially heavier train up it than the other; and that on such tracks an engine will work up to a much higher power than the formulas indicate as a maximum. It would appear to be fair to assume that the ratio of increase would not be less than is found to exist between loads that can be drawn up a track in good order compared to one that is in bad order, slippery, &c. But even if the ordinary rail was used in the rainy season, the track can be relied on to give the maximum of adherence, if the simple expedient is resorted to of sprinkling sand on the rails from a sand-box in front of the drivers, which is well known to answer even if the track is covered with sleet, snow, or ice.

The loads, therefore, that correspond to an engine of the pattern and weight last referred to, viz: of $27\frac{1}{2}$ tons, will be—

For maximum grades of 300 feet, $81\frac{1}{4}$ tons, or 44 tons net freight.

For maximum grades of 280 feet, $86\frac{3}{4}$ tons, or $47\frac{1}{4}$ tons net freight.

For maximum grades of 260 feet, 93 tons, or 51 tons net freight.

For maximum grades of 250 feet, $96\frac{1}{2}$ tons, or $52\frac{1}{2}$ tons net freight.

For thirty-ton engines, with a tender, the loads will be, exclusive of the weight of the latter—

For maximum grades of 300 feet, $86\frac{1}{2}$ tons, or $48\frac{1}{2}$ tons net freight.

For maximum grades of 280 feet, 93 tons, or 52 tons net freight.

For maximum grades of 260 feet, $100\frac{2}{3}$ tons, or 56 tons net freight.

For maximum grades of 250 feet, 105 tons, or $58\frac{1}{2}$ tons net freight.

Heavier engines will, of course, draw larger loads, and such could, without doubt, be advantageously used on broader rails than those now in common use.

It would seem that, with such loads per locomotive, a transit route of not excessive original cost could be made to pay, without resorting to any unusual descriptions of engines or rolling stock generally. That the grades, which correspond to the loads respectively, will enable the track to be located without doubles, or great embankments or excavations, will be evident upon examination of the profile of the route I recommend; the average grade of which is, on the Atlantic slope, 261.3 feet per mile, and, on the only steep portion of the Pacific

slope, viz: that between the cañon and the summit, somewhat less than 290 feet per mile; the maximum grade on the former being, as the road is proposed to be located, 300 feet, and on the latter 280 feet. From the examination of the region that I was enabled to make, I should say that the track could commence to gain altitude, almost immediately after leaving the terminus in the lagoon, at a rate of 130 feet per mile, and continue to do so, following very closely the natural configuration of the spurs and hills, until the spur is reached, at whose foot flows the Cylindro, affluent of the Changuinola, where a grade of 300 feet will probably be required to overcome the remaining 4,100 feet of the ascent. Such a road, with curves of a minimum of 300 feet, could wind up to the pass without perhaps a single viaduct and but few bridges, viz: those over the two or three intervening affluents of the Changuinola, and with no greater amount of excavation and embankment, which would be chiefly due to the road being in side forming for a great part of its course.

I have stated most of the grounds upon which is based my preference for a system of high grades and curves bold enough to wind around the sharpest spurs that the country presents, and showed that by such system an excessive use of viaducts, embankments, excavations, tunnels, &c., could be avoided, as well as a resort to doubles, which, although an efficacious substitute for curves and much preferable to tunnels, are open to the objections already pointed out, and which would entail also the necessity of crossing a second time some ravines, and tunnelling or winding around some spurs. These considerations refer to the preparation of the road-bed, but do not include all that bear on that point. Throwing aside calculations based on the additional difficulties per mile of road that accrue in proportion as the grade is fixed at a lower figure, and supposing the expense of such preparation to be merely in proportion to the length of the line, it will be seen that with grades averaging 260 feet per mile the length of road will be no more than half what a grade of 150 feet would require. The amount saved in consequence of the shortening of the road will therefore be a very considerable item, in addition to the construction of all kinds that would be saved by taking a route that should go more directly towards the point aimed at. The amount saved likewise in the quantity of rails, cross-ties, and other parts of the track itself, and the cost of constructing the latter, forms an important item.

It will also be recollected that the vertical height to be mastered remaining the same, the power required to draw up a given train will be much less on a steep grade than on an easy one; the difference being the work that would be expended in drawing the train over a level road as long as the difference in length of the two grades, which, as I have shown, may amount to more than the whole length of this part of the road, if it were located on a grade of 300 feet. The only mechanical difficulty that has not been discussed in regard to the working of the description of road here recommended relates to the curves, which, to such as are not acquainted with the improvements that have been effected in regard to them may appear excessively sharp. The points that must be considered in this respect are, the

unequal pressure on the rails, caused by the centrifugal force of the engine and train; the biting of the wheels on the rails, which is due to their not revolving in planes tangent to the curves; and the sliding friction or dragging of the wheels on one side, due to their travelling over unequal distances. These difficulties may, however, be entirely obviated for curves much sharper than is generally regarded as the limit, and even less than the radius of curvature named as the minimum in the road proposed. A suitable elevation of the outer rail, the use of wheels free on their axles, of locomotive with its train, according to the statements of M. Flachet, to turn in curves of 80 feet radius on tracks of the usual gauge with reduced speed, but without great friction or perceptible instability. It would seem possible that the same results could be obtained by another expedient, viz: an imitation of the curves on street railroads, which employ a flat outer rail, on which the edge of the flange of the outer wheel travels, the inner rail being deeply grooved or else provided with a guard-rail to hold the cars on the track; by making the flanges of a height to suit the ruling curves, it is evident that great facility for passing them could be gained. This expedient was resorted to in 1830 on the Baltimore and Ohio railroad, and I believe remained in use for some three years, answering its purpose, which seems to have been temporary. Neither this, nor any other arrangement in which the axles of the wheels remain parallel to each other during the passage of the curve, forms a mathematically exact solution of the problem, as each pair of wheels is prevented by the others from travelling in such manner that the axles shall constantly remain normal to the curve, and consequently a certain degree of sliding of the wheels on the rails is unavoidable, but this may, as has been shown, be reduced within not material limits.

On the Mountain Top road the ruling curves are described with radii of 300* feet, on which the grade is $237\frac{6}{10}$ feet per mile. These are travelled at the rate of seven and a half miles an hour on the ascending grade, and from five and a half to six miles on the descent. The cars are of the ordinary construction; the engines have been described above.

In regard to the amount of resistance due to the curves positive information seems wanting, although various formulas have been deduced for its value. In Captain McClellan's report it is stated that on the Pennsylvania Central the grade is reduced on curves at a rate of 0.025 per hundred feet per degree of curvature. On the Mountain Top road the increased traction due to curves of the radius above mentioned was compensated for by allowing a difference of 43 feet on the western side of the mountain, and 58 feet on the eastern, between the grades on curves of 300 feet and those on straight portions of track. With this allowance, aided by the expedient of keeping the *flanges* well greased, the difficulty of turning the curves has been so far diminished that it is no longer possible to determine whether grades of $237\frac{6}{10}$ feet per mile, on curves of 300 feet radius, or grades of 296 feet per mile on straight lines, are traversed most rapidly.

* There is one curve of 234 feet, the grade on the curve being 238 feet per mile.

The limit proposed by M. Flachet for the radius of curves appears extremely low, and I should not recommend the road to be attempted if the configuration of the country was so excessively rugged and difficult as to necessitate a resort to curves of even 100 feet radius; and although 150 feet is a practicable radius,* I should prefer to have the line located, as it doubtless can be, with curves of a minimum radius of 300 feet, the efficiency of which has been satisfactorily established, because for traversing such curves no other expedients than such as have received the sanction of experience are required.

The above remarks on curves complete the crude discussion which I deemed appropriate in connexion with the opinion advanced in regard to the practicability of the route for a railroad. It is my confident belief that a survey with proper instruments will establish the feasibility of locating on the Atlantic slope a road which, by following closely the configuration of the hills, climbing their sides at high grades, and rounding the spurs and ridges without great alteration of the natural contours, shall be kept within not excessive limits of cost. It has been shown that within the limits specified and recommended of grades and curves, such track can be worked with locomotives and cars of patterns and weights that have received the sanction of experience, and there can be no doubt that the amounts of net freight which it has been shown can be carried to the summit per trip of the engines are sufficient, with certain articles of freight, to render such trips profitable; in a word, that the route is a practicable one for railroad purposes, without supposing resort to be had to any unusual expedients, such as new patterns of locomotives, cars, &c., in the rolling stock, or to the resort of doubling the line on the slopes, or to inclined planes, or to tunnels of other than very short extent, that may be found the cheapest way of passing uncommonly thin and sharp spurs.

The route which I suggest should be surveyed with a view to locating, finally, the road, and which there can hardly be a question will be found to be sufficiently adapted to receive it, providing the specified limits of grades and curves are adhered to, may be described as follows, viz:

From the pass the line should follow the right slope of the ravine of Westcott's river, on a grade of 300 feet per mile, until that ravine joins the next one, (located on the map,) when it should curve around the dividing spur and enter the latter, pursuing a similar winding course in the valley of each affluent of the Culebra, that is of any considerable size, (two, according to my information,) until it finally reaches the right bank of the Culebra valley proper, which it will follow to the forks of that river. Assuming that the development of the line can be made by winding down the hills as proposed, nearly double the distance by the stream, or 13.7 miles, the grade specified will arrive at the Culebra forks at about the level of the river.

This point is 2,162 feet above the level of the Chiriqui lagoon, but between it and the coast the hills are not as difficult, steep, and rocky

* This is stated in Captain McClellan's report, which adds that even less is practicable, provided the velocity is greatly decreased.

as in the tract above. I should propose to descend from thence on a regrade of 129 feet to the mile, following the right bank of the river until the edge of the spur is reached which divides its upper valley from that of its affluent, the Romero, which may be crossed by a bridge of eighty feet span; the line will continue on the right bank of the Romero until it attains the divide between it and the Robalo river; curving around this spur, which is a large offshoot from the Cordillera of Monte Frio, it will cross the latter river a little below the Tres Brazos, and from thence skirt the edge of the swamp or flat, close to the bases of the coast hills, until it reaches Frenchman's creek, at its mouth, where an excellent depth of water can be had for the wharves of this terminus of the line.

It is probable that if the road is decided upon, a tunnel will be judged advisable to reduce the ascent, by piercing through from the cañon at station No. 9 to a point opposite to it on the Atlantic slope. Such a tunnel would cut off 2,200 feet of altitude, with the expense due less than four miles of excavation. The point at which the tunnel should emerge on the Pacific slope could, no doubt, (in view of the fact that the proposed route describes an arc of a circle nearly around station No. 9 as a centre,) be located so that the track laid and in use during the construction of the tunnel might be connected with that laid through the tunnel. The cost of the latter could more reasonably be undertaken, considering that during its construction the property and lands belonging to the company would be increasing in value and the resources of the country developed by the road; the revenues of the latter will also be a great assistance, and might render such an undertaking practicable even if on a greater scale than the configuration of the region of the summit is found to demand; and the road would offer great facilities for the work on the tunnel.

Appended to this report will be found some remarks respecting another transit line which is, in my opinion, worth the expense of a survey, (see document A, Appendix;) the very scientific and creditable report of Mr. Henry C. Fillebrown, to whom I turned over all the barometrical observations recorded by me or my assistants, and who made from them all the computations for altitude used in the construction of the profile of the route, (document B.) He applied in his calculations the system which has of late been used by the corps of topographical engineers, which seems to have gained some remarkable verifications by the results of the survey.

There is also appended a brief description (see document C) of the different varieties of woods I met with on the isthmus; these merit a closer examination than my time allows; I collected specimens of all the varieties described and several others, which are in my possession and subject to the order of the Navy Department.

A map reduced by Mr. Francis Herbst from the plot of the survey by Mr. Jekyll and other sources, and a profile of the lines by Mr. Jekyll, are also appended.

In concluding my report, the very valuable services rendered me by Mr. Thomas Jekyll, my first assistant, deserve especial mention. Since I handed you, on board ship, my *preliminary* report, I have received statements and explanations which show that such report, and the

letter of censure I addressed to the head of the detached party on my return to the ship, contained strictures that were not deserved; and regard it as due to Mr. Wilson to acknowledge that he acted conscientiously, according to his interpretation of his instructions, in determining to give up further explorations when he did, and omitting to make the instrumental survey of the Atlantic slope; and to state that, as far as he and Mr. Babcock surveyed the cañon, their work was executed in a highly satisfactory manner.

It is with pleasure that I acknowledge courtesies and offers of assistance extended to me while on the isthmus by Don Lorenzo Gallegos, the prefect of the province.

I append thirty sketches of the country, which embrace nearly all the interesting features of the Pacific slope, and of the coast between David and the head of Golfo Dulce, and of the vicinity of the termini on both sides.

In conclusion, I beg to refer to the haste with which, from the necessity that exists of laying the report of the commission before Congress, I have prepared this document, (and the accompanying map, profile, &c., &c.,) in explanation of such defects of style, arrangement, and perspicuity as will be observed in the former and the absence of more detailed information in the latter.

I am, sir, very respectfully, your obedient servant,

J. ST. C. MORTON, *Top'l Eng'rs,*
Member of Chiriqui Com'n, in charge of Top'l Division.

Captain F. ENGLE, U. S. N.,
Commanding Chiriqui Commission.

DOCUMENT A.—APPENDIX.

There is another line across the isthmus which my information warrants me in recommending to be examined before the location of the transit route is finally decided upon. This line would ascend the affluent of the Colebra, which is next below the one followed by my route, and crosses the divide at a point to the northwest of the peak of the volcano; here it would enter the region of the sources of the Chiriqui Viejo, and may descend one of its tributaries until it arrives at the line of demarcation between the hills and the flat lands; from this point to the Golfito its location coincides nearly with that of the route by way of the pass on the eastern side of Monte Horqueta, viz: either skirting the edge of the flats and crossing the Colorado and Coto above them, until it arrives at the base of the range of hills which divides the Coto from the Golfito, or running directly across the flats to the same point, when it follows the base of the hills through the depression north of Floyd Peak into the harbor of Golfito.

By adopting this route, if the summit is not too high and it should prove practicable in other respects, the crossings of the Cochea, Piedra, and Chiriqui Viejo rivers would be saved, and the line would be shortened by about twenty-five miles.

I was led to inquire into this line by observing, while at Punta

Arenitas, that the main ridge of the Cordilleras seemed but little higher on the western side of the volcano than on the eastern, as is shown in view No. — appended; and afterwards, in passing through the province, I was informed by several parties that the Terraba Indians were in the habit of going to Boca del Toro by way of the western side of the Volcano, using a picadura that was described to me as above.

The chief difficulty in this line is, that on the Pacific side it does not (according to the statements I received) present the facilities for the road bed that are offered by the savanna slope of the route surveyed by me; on both sides of the summit the line must be located in a region of sharp cones, spurs, and ridges, such as form the only difficult portions of the latter.

The Guaromo route, whose summit is at an altitude of 5,577 feet, being 693 feet lower than that of the Toucey cañon route, is not as advantageous as might appear from that circumstance alone. On the Pacific as well as the Atlantic slope the country is at first very rugged and the natural grades exceedingly steep; it is also the longest of the three routes, and must cross two rivers which they escape, viz: the Algarobo and Rio de las Valles. I should regard it as the least promising route that has been examined.

DOCUMENT B.—APPENDIX.

Barometrical report.

WASHINGTON, January, 1861.

SIR: Accompanying you will please find a tabular statement of elevations obtained from a discussion and computation of the barometric readings taken by yourself and the members of your party during your recent exploration.

The method made use of in constructing the curves from which the tables of horary and abnormal corrections were obtained, is the one which has been so fully and elaborately described by Lieutenant Henry L. Abbot, topographical engineers, in volume six Pacific Railroad Reports. He covers the ground completely in his treatise, and the practical results are a perfect demonstration of its truth.

After reducing the barometric readings to what they would be at a temperature of 32° Fahrenheit, I then plotted the hourly observations of each barometer with great care. After a careful study of the results, I determined to adopt barometer No. 1265 as my standard, that instrument having given decidedly the smoothest and most perfect curve, and having seemed to have preserved its original status during the whole period of field operations; whereas barometers Nos. 1376 and 1258 were decidedly out of order on the 16th September, and remained so until the 29th, when they seem to have been repaired. No. 1380 also read too low, and the French barometer read uniformly too low, although I was not able, by comparison, to deduce any positive correction to apply to it.

Having a large number of observations, I determined to use them all in constructing my horary curve, although a good result might have been obtained from a single week's observations, and the accompanying beautiful curve is the result of the combination of over 600 hourly observations. Taking then the grand mean of all the observations, together with the mean of the attached and detached thermometers, I used the result as the datum line for the subsequent calculation of the elevations taken in the field.

You were so fortunate as to obtain, on the Pacific side, a series of observations extending over a period of three days. From these observations I have also deduced a horary curve and table of corrections to be applied to the observations taken on that side of the summit.

After completing these computations I applied the horary correction to the observations taken at "Fish creek." The observations thus corrected were then plotted, forming a curve which represented the abnormal oscillation alone at that point. The table of corrections obtained from a comparison between the datum line and the individual hourly observations is applicable to all the observations taken in the field, and enters into all my calculations of elevations.

The system of hourly observations at Fish creek was abandoned on the 17th October, but observations were taken at such hours (between 5 a. m. and 6 p. m.) as to enable me, by interpolations, to obtain fixed values for each hour's reading.

"In making the calculations of elevations I have used the tables of Professor Elias Loomis. After applying the four necessary corrections, (instrumental error, temperature correction, horary, and abnormal,) the remainder of the calculation was made in a short time, as these tables are exceedingly convenient, and, not introducing logarithms, greatly diminish the liability to mistake."

The observations seem to have been taken with a great deal of care, and the results are very satisfactory. I regret exceedingly that the limited period allotted for the completion of the work has forced me to forego the gratification of writing a full discussion of the whole subject, but justice to myself forbids that I should enter upon such a field, without first having an opportunity of examining standard authors upon the subject and making myself more familiar with it. The following examples of the computations made will give an idea of the closeness of the results obtained. The following observations have been taken at the same point upon different dates :

Camp at Alto Boquete. From September 4 to September 13, inclusive.

h' is the mean of 58 observations corrected for abnormal and horary oscillations.

H is the mean of all the observations taken at "Fish creek."

T = attached thermometer. T' = attached thermometer, $71^{\circ}.9$. t = detached thermometer. t' = detached thermometer.

	$H = 29.920$	$T = 81^{\circ}.1$	$t' = 84^{\circ}.1$	
	$h' = 26.155$	$T' = 71^{\circ}.9$	$t' = 70^{\circ}.4$	
Part 1 gives for	{ H		27539.9	
	{ h'		24026.2	
			3513.7	
Part 2 gives for $T - T' = 9^{\circ}.2$			- 21.6	
Approximate altitude A			=	3492.1
$\frac{a}{900} (t + t' - 64) = 3.88 \times 90.5$			=	+ 351.1
2d approximate altitude A			=	3843.2
Part 3 gives for $A = 3843$ and $L = 9^{\circ}.30$			=	+ 10.2
Part 4 gives for 3843			=	+ 10.3
				3863.7

Rancho de Don Lorenzo, Gallegos, November 2. (2 observations.)
Verification readings.

H is the mean reading at "Fish creek."

h' is the mean of the two readings at the above station, corrected for temperature abnormal and horary oscillations.

	$H = 29.920$	$T = 81^{\circ}.1$	$t' = 84^{\circ}.1$	
	$h' = 26.155$	$T' = 73^{\circ}.5$	$t' = 71^{\circ}.0$	
Part 1 gives for	{ H		27539.9	
	{ h'		24026.2	
			3513.7	
Part 2 gives for $T - T' = 7^{\circ}.6$			- 17.8	
Approximate altitude A			=	3495.9
$\frac{a}{900} (t + t' - 64) = 3.8843 \times 91.1$			=	+ 353.9
2d approximate altitude A			=	3849.8
Part 3 gives for $A = 3850$ and $L = 9^{\circ}.30$			=	+ 9.6
Part 4 gives for 3850			=	+ 10.4
				3869.8
Result from readings in September, as above				3863.7
Difference, in feet			=	6.1

This is a very close result, and is true. I had no intimation that the observations at these different dates had been made at the same point, and I regard the example given above as a proof of the correctness of the method of computation used. Appended you will please

find the horary curve, together with the "mean readings," from which it was constructed. The table of horary corrections is obtained by applying the datum line to the curve, and the differences represent the \pm corrections. The table of horary corrections is also annexed, together with the table of elevations obtained from the computation of the field observations.

Very respectfully, your obedient servant,

HENRY C. FILLEBROWN.

Lieut. J. ST. C. MORTON,
Chiriqui Commission.

Elevation of the different points along the line of survey.

Station.	Date.	No. of observations.	Elevation.
	1860.		<i>Feet.</i>
Guaromo	August 26	1	21.4
Camp at Caraña	" 27	1	1,198.0
Camp at Quebrada Bonita	" 28	1	3,028.1
Monte Frio	" 29	1	5,577.1
Camp at Goyabo	" 30	1	4,928.8
Camp at Potrero de la Bargas	" 31	1	1,363.3
Camp at Caldera	September 2	1	1,216.1
Camp at Alto Boquéte	" 4 & 13	58	3,863.7
Ciudad de David	" 15	1	184.1
Alaujé	" 18	1	133.9
Camp No. 1, on Rio Golfito	October 7	2	158.5
Camp No. 2	" 8	3	205.1
Camp No. 3	" 9	1	267.1
Camp No. 4	" 10	1	137.4
Solano	" 25 & 26	8	853.4
Boqueron	" 27	2	1,777.9
Bank of Rio de David, in cañon	" 29	1	784.5
Top of cañon	" 29	1	916.3
Puebla de Dolega	" 29	1	950.4
Cochea, (rancho de Nie river)	" 30	11	1,325.7
Near Obaldéa's Hill	November 2	3	2,737.4
Rancho de Don Lorenzo Gallegos	" 2	2	3,869.8
Hut Bajo Boquéte	Sept. 5 & 6	3	4,069.3
Crossing of Caldera, in cañon	" 5	1	3,823.3
In cañon at Camp No 2, or sta. 32,008	November 4	2	4,930.5
Summit of dividing ridge between cañon and Boquéte	" 5	1	6,705.4
Summit of Monte Horquéte	" 6	1	7,597.5
Source of Westcott's river, in the pass	" 7	1	6,270.8
Camp No. 5, on Westcott's river	" 7	1	3,896.7
Camp No. 6, junction of Rio Colebra and Cylindro	" 8	1	2,162.3
No. 18 of survey between camps Nos. 6 and 7	" 11	1	2,735.7

NOTE C.—APPENDIX.

There seems reason to expect that the system proposed by M. Flachat, for the rolling stock on railroads constructed on very high grades, would, if applied on the road I recommend to be adopted, augment the proportion of paying freight to the gross weight of each train, to a degree that would enable almost all sorts of freight, even the most bulky and cheap, to take advantage of the transit route.

It is best described by showing its main point of difference from the ordinary system. In this the power of the locomotive is limited to its adherence, which depends on its weight; and, as the latter is usually restricted to within thirty tons, the force of traction cannot exceed six tons, being one-fifth the weight on the ordinary rails. This, then, is the force disposable to overcome the aggregate of the friction of a train and its tendency to run down grades. The former item is, of course, constant, being $\frac{1}{230}$ of its weight, but the latter is composed of two factors, one of which, the component of gravity parallel to the slope, increases with the grade, the other being the weight of the train, and of course must decrease as fast as the other increases, the product of the two being constant.

The plan of M. Flachat consists in managing to carry a large boiler with a great extent of heating surface, and to distribute the motive power through the train so that each car shall have its own force of traction, which shall be utilized by the friction caused by its own weight. In this arrangement it is evident the limit of the force of traction is not the adherence of the locomotive, but that of the entire train, which being proportional to its weight there is no limit to the train except the quantity of steam that can be furnished from the boiler for its propulsion, and no grade accessible to a single locomotive without load that it cannot ascend. Without entering into the details of the plan, it consists in placing a cylinder in connexion with the wheels of each car, and also by a steam pipe with the boiler in front of the train. The boiler, which is much larger than common, is rendered practicable by reducing the machinery of its carriage to the power required to propel it alone, which, it will be seen, admits also of a considerable reduction in the weight of the carriage itself, and by placing it on two trucks like the other carriages. To calculate the results which may be expected from M. Flachat's plan when perfected would require a thorough insight into some practical and mechanical branches of railroad engineering, and the building of boilers and locomotive machinery; and as it has not received the sanction of experience, nor, as far as my knowledge extends, of practical men in this country, I do not feel competent to express an opinion on the subject, nor to comment on the calculations of M. Flachat, which state the performance of his machines greatly above those of the style of the usual style of locomotive in regard to the size and weight of the boiler, its heating surface, the quantity of water evaporated, and the force of traction that can be maintained at given speeds, especially as his estimate is for a speed of ten miles an

hour, which is double what I should regard as the limit of security until the rate practiced on the mountain top road has been safely exceeded on equally steep grades. There can, however, be little doubt that if the inventive genius of this country was interested in perfecting the mechanism suggested by M. Flachet, trains of a not too costly pattern and of a size to give good profits could be drawn over such a road as I have proposed to locate. It will be recollected that the amount saved in length of road, and in economy of construction of the road bed on such road, would leave a large margin disposable for outlay on rolling stock.

DOCUMENT D.—APPENDIX.

The *mangle caballero* is a light red wood, of a close grain. It will make good cross-ties. It is used in New Granada for the framing of houses, especially in floor and balcony beams; also for ship timber.

The *mora* (or *macano*?) is a large tree. Its wood is yellow, with a grain resembling poplar. It has a peculiar smell. It is used as a dye-wood, and for the posts and sills of houses. It is very durable, even when partly imbedded in the earth.

The *cedro amargo*, or *cedro real amargo*, is the best of several varieties of cedar. It resembles our cedar in most respects; is used for furniture, house carpentry, and small carpentry of all kinds, and for making canoes. I have specimens of two or three kinds of cedar.

The *guallacan*, or *lignum-vitæ*, grows to a size of five feet in diameter. Its uses and properties are well known.

The *roble* is a whitish, light wood, with a grain something like cedar. There are three kinds of roble, one of which is the black. It is used for ribs of vessels and doors, and makes good planks.

The *sorillo* is a dark red, hard, close-grained, heavy, and tough wood. It is durable, and valuable for furniture, for veneering, &c.

The *caucho*, or India-rubber tree, grows in abundance in Chiriqui, especially in the neighborhood of Bogaba, Bogabita, and Solano. Its wood is yellow, soft, and close-grained, with a peculiar odor.

The *pimiento* is used for the same purposes as the *mangle caballero*.

The *valsa* is an extremely soft, light wood, of white color. Even when green it makes a light raft, and is good fuel.

The *calabasa de playa* (or beach calabash tree) is a white, lightwood. It is tough and elastic, and makes good timber and knees for boats and vessels.

The *gabilan* is a whitish wood, tough and close-grained. It is used in framing.

The *cedron* bears a nut which is very bitter, and is sold to make a substitute for quinine. It is said to be useful in fevers, and as an antidote to snake bites. The wood is tough and close-grained, heavy, and of a white color mixed with gray.

The *mangle marigueta* is a light wood of yellowish color, straight-grained and durable.

The *malagueto* is an excellent wood for many purposes. It is of a dingy white color, tough and strong.

The *guallabo* bears a nut that is fed to hogs. Its bark is very thin and smooth; the grain close, but light.

The *coloradito* is a wood between the cedar and mahogany, of a red color, and is used in frames of houses.

The *corta-lengua* is used for heavy beams.

The *algarobo* is used for the chief parts of sugar-mills.

The *guanabanillo* is a very soft, white, light wood, of compact texture, and is used for the same purposes as the *algarobo*, and in floor beams. It is said to last thirty years.

The *cocoa*, *lemon*, and *orange* grow in Chiriqui.

The *caimito* is a very hard, compact wood. It is durable, and is said to last a dozen years in the ground.

The *palo das-caros* is a dingy-colored, moderately heavy, close-grained wood, and is used in roof and floor beams.

The *mamaicillo* resembles birch. It is reddish-white, and tough. It is extensively used.

The *maria* is a white, light, soft, straight-grained wood. It is used for spars and masts of vessels.

The *jagua de montaña*, a red, heavy wood, the *managua de playa*, a very light wood, and the *sigua amarilla*, are likewise useful varieties.

Specimens of mahogany, and several other sorts of wood, which grow in Costa Rica and Chiriqui, are also submitted. In general it may be stated that the woods of Chiriqui and Costa Rica are strong, durable, heavy, and close-grained, and of high value.

NOTE E.—APPENDIX.

The mountain top track crosses the summit of the Blue Ridge at Rock Fish Gap, where the elevation of the mountain is 1,885 feet above tide. The crest of the ridge is very narrow, and is passed on a curve of three hundred feet radius.

It was constructed as a temporary communication across the mountain during the time that a tunnel was being made through the latter. The idea was to accommodate the wants of the public in the meantime, develop the business of the road, and make it pay while the heavy expenditure on the tunnel was being made.

The locomotives for this road were constructed by Baldwin & Co., of Philadelphia. They are mounted on six wheels, all of which are drivers, and coupled, and forty-two inches diameter. The wheels are set very close, so that the distance between the extreme points of contact of the wheels and the rail, of the front and rear drivers, is nine feet four inches. This closeness of the wheels of course greatly reduces the difficulty of turning the short curves of the road.

The diameter of the cylinders is $16\frac{1}{2}$ inches, and the length of the stroke twenty inches.

To increase the adhesion, and, at the same time, avoid the resistance of a tender, the engine carries its tank upon the boiler, and the foot-board is lengthened out and provided with suspended side boxes, where a supply of fuel may be stored. By this means the weight of wood and water, instead of abstracting from the effective power of

the engine, contributes to its adhesion and consequent ability to climb the mountain.

To enable the engines better to adapt themselves to the flexures of the road the front and middle pair of drivers are held in position by wrought iron beams, having cylindrical boxes in each end for the journal bearings, which beams vibrate on spherical pins fixed in the frame of the engine on each side and resting on the centres of the beams. The object of this arrangement is to form a truck, somewhat flexible, which enables the drivers more readily to traverse the curves of the road.

WASHINGTON, *January 22, 1861.*

SIR: Having been charged with the survey of the harbors at the termini of the proposed road across the Isthmus of Chiriqui, I have the honor to submit the following report, accompanied by a chart of the harbor of Golfito, the Pacific terminus.

In the prosecution of the duties assigned me as hydrographer to the Chiriqui commission, I submit the following plan of the objects of my survey:

On the Atlantic side: 1. An examination of the Bocas del Toro, Drago, and Tigre, to see if any changes had taken place in the twenty years elapsed since the survey of Commander (now Captain) Barnett, R. N., in 1838. 2. A detailed survey of such points as should be indicated as suitable termini for the proposed road. 3. Whenever the ship should be moved, to verify the general chart of the lagoon.

The distinguished reputation of Captain Barnett as a surveyor was a sufficient guarantee of the fidelity of the original surveys; I was therefore content to recover several of the prominent points of the survey, and from them fix the positions of the additional soundings, which I plotted directly upon his published chart.

These soundings were principally taken upon the leading lines and ranges in, and I find that no material changes have taken place at either of the entrances into the lagoon, and that his original ranges still afford excellent marks for entering the various harbors. Indeed, these were so prominent and well marked, and so satisfactory were the very first examinations, that the United States steamer Brooklyn, under the command of Captain Farragut, was, with perfect confidence, run into every part of the lagoon without the aid of a pilot.

In the absence of any information as to the probable terminus of the proposed road, I made a detailed survey on a large scale of the portion of the coast between the mouths of the Guaromo and Robalo rivers, the only point suitable in a hydrographic point of view. The most favorable spot is at the mouth of Frenchman's creek, where an indentation of the shore-line forms a small bay, 800 yards in width, which has been named Toucey bay.

At this point, five fathoms water is found at a cable's length from shore; three fathoms within thirty yards. Piers could then be run out to sufficient depth of water at a small expense. The average rise of the tide is one foot five inches. The anchorage unexcelled. This anchorage is open to northerly and easterly winds; but from the best

information I was able to obtain, they never blow with sufficient force to raise an injurious sea.

In order to obtain an anchorage of undoubted security, I also examined Shepherd's harbor, to which point the road could, without difficulty, be taken. This is a completely land-locked basin, with great depth of water everywhere sufficiently near its shores for the formation of piers at small expense.

In short, no finer harbors than these can be found, and they are so faithfully laid down by the English surveys that a consultation of the charts will give a better idea of them than any description.

After completing the surveys on the Atlantic side, I proceeded to Panama to await transportation to the Golfito in the Golfo Dulce, the Pacific terminus. Owing to various causes heretofore reported on, it was not until after a delay of upwards of a month that I was enabled to reach the Golfito, to which place myself, assistant, and a boat's crew from the United States ship *St. Mary's*, were, by the liberality of the Panama Railroad Company, conveyed gratis in their steamship, the *Guatemala*, which touched off the port for me on her return. I would here express my acknowledgments to the superintendent of the company, and to Mr. Wm. Nelson, their commercial agent at Panama, also to Captain John N. Dow, of the *Guatemala*, for their kind attention and assistance. Also to Commander Wm. D. Porter and Lieutenant Balch, executive officers of the United States ship *St. Mary's*, for the complete and careful equipment of the boat furnished by that ship.

As the Golfito had never been regularly surveyed, it became necessary to make a complete trigonometrical survey, which, with the aid of Second Assistant Engineer G. B. N. Tower, United States navy, was successfully accomplished by the time fixed for the return of the *Guatemala*.

This beautiful harbor, situated twenty miles from the Punta del Banco, on the eastern side, and midway between the entrance and bottom of the Gulf of Dulce, is unsurpassed in natural facilities.

Favorably situated for entering with the sea breezes and leaving with those from the land, both of which are regular, there is no bar or other obstruction at the entrance, which is upwards of half a mile (1,200 yards) wide and about a mile in depth, with an excellent anchorage on good holding ground, in five, seven, and twelve fathoms; having the chart, no other guide than the eye is necessary. This outer harbor is separated by a sand spit, a mile in length by a few feet in width, (around the northern extremity of which there is an excellent channel, eight hundred yards wide, with upwards of five fathoms of water,) from the inner harbor, four miles in length, with an average breadth of one mile.

The inner harbor has about a square mile of anchorage, with a depth of five fathoms, (sufficient for the largest ships,) and about three square miles of anchorage for vessels of a smaller size.

On the northeast side of the harbor opposite the entrance, there is a range of hills several miles in length, parallel to the coast line, of an average elevation of about fifteen hundred feet, leaving a strip of

level generally of but a few yards in width between their bases and the shore line. On this side of the harbor, and for a distance of upwards of three miles, not less than five fathoms of water is found within half a cable's length of shore, affording ample room for wharves sufficient to accommodate any probable number of vessels frequenting the harbor, if the proposed road should be built.

Three streams—the Golfito at the eastern, and the Corisal and Cañaza at the northwestern extremity—empty into the harbor; neither of these navigable, but either affording an ample supply of fresh water for the proposed town.

There is one level spot sufficient for the site of a large town; but the several valleys running back from the shore, in the aggregate, would give about a square mile of suitable building sites. The whole surface, to the tops of the highest hills, is densely wooded, excepting the sand spit and a small spot of about three acres near the entrance, under cultivation. A great variety of these woods are valuable for ship building or for other constructions; different woods excelling in the qualities of durability, hardness, and strength.

The cocoa-nut and caoutchouc or India-rubber trees are abundant. One family resides at the harbor, but on the opposite side of the Gulf of Dulce, at Punta Arenitas, there is a village of some thirty families, and small settlements exist at several other points.

The survey was commenced in the worst month of the rainy season; but as it seldom began to rain before 3 p. m., I experienced no difficulties in the prosecution of the work from this cause. From 3 p. m. until midnight the rain was usually heavy and continuous, but the mornings were clear and pleasant, the temperature cool and agreeable—average: 6 a. m., 74°, meridian, 83°, 3 p. m., 84°, 6 p. m., 78°.

Shortly after my arrival at Golfito, Lieutenant Morton, United States army, in charge of the topographic party, arrived in a state of destitution—in want of money and supplies—both of which I furnished in sufficient quantity to enable him to continue his reconnoissance.

I was also applied to by the governor of Gulf of Dulce, requesting me to render him assistance in apprehending some lawless characters at Punta Arenitas who defied his authority. I did not consider that it would be expedient to assist him further than by a loan of arms and ammunition, the mere sight of which in his hands caused them quietly to submit and be shipped off in irons to Punta Arenas, in the Gulf of Nicoya.

It is, perhaps, as well to mention that the whole of the Gulf of Dulce, as far as Point Burica, is under the political jurisdiction of Costa Rica, and that eighteen political prisoners, comprised in the late attempt at revolution under ex-President Mora, had been banished to, and were daily expected at, Punta Arenitas when I left.

The only remaining point to be considered is the grant of land to the United States government, under the contract with the Chiriqui Improvement Company. If the road should be opened, I am of the opinion that the lands would become very valuable. Without that

condition they are valueless, as large tracts of vacant land can be obtained by the process of denouncement, gratis.

Very respectfully, your obedient servant,

WILLIAM N. JEFFERS,

Lieutenant, Hydrographer of Chiriqui Commission.

Captain FREDERICK ENGLE,

Commanding Chiriqui Expedition, United States Navy.

Geological Report of Dr. John Evans.

WASHINGTON, December 31, 1860.

SIR: On the 28th ultimo, at Norfolk, Virginia, I submitted a brief statement of the general results of the examinations made, by order of the Secretary of the Navy, to ascertain the extent and value of the coal deposits on the lands of the Chiriqui Improvement Company. Since that time opportunity has been offered me to have careful analyses of the coals made by a distinguished chemist, Dr. Charles T. Jackson, of Boston, Massachusetts, and to have the fossils associated with the coal examined by experts in paleontology, to determine the true geological age of these deposits. The quality of the coal proves to be better than stated in my preliminary report. My present communication will be a simple exposé of the facts developed by these investigations, and a brief allusion to the other minerals, as well as the agricultural resources of the country explored.

In a letter from Dr. Jackson, dated December 15, 1860, he states: "That it is obvious, from the qualities and composition of the Chiriqui coal, that it is well suited for steam navigation and all ordinary uses, and it is a nice, clean coal for grates. It produces heat with great rapidity, its flame being very large and well sustained, while the coke is of good quality, and the ashes of small amount. Distilled in close vessels, fine and bituminous liquids or oils are obtained. In the retort they give out an abundance of highly illuminating gas, very rich in carbon." In another communication he calls it "a very fat, bituminous coal, yielding 40 per cent. of oil." These coals kindle with ease, and steam can be raised in about one-third the time required in the use of anthracite. Under some circumstances this facility might prove of great value to the honor and prosperity of the nation.

In order that the true value of these deposits may be properly understood, I will state that all the coals analyzed are surface specimens, more or less deteriorated by atmospheric influences; and in some localities on the shores of the islands in the lagoon, and on the mainland, where they crop out at the water's edge, as at Pope's island, they are covered with salt water at every high tide. All experience in mining proves that the coals will much improve in quality as you penetrate deeper into the veins.

These coals are almost entirely free from sulphur or iron pyrites; in most specimens only a trace of either can be found. The largest

percentage in any of the specimens analyzed is $\frac{1.89}{100.0}$ of one per cent. It appears from this fact that the coal is not liable to spontaneous combustion.

Deposited, as this extensive and almost inexhaustible coal field is, at the largest and safest harbor on the Atlantic coast, opposite to another harbor on the Pacific capable of receiving at safe anchorage all the shipping engaged in commerce between Europe and Asia; with a country rich in mineral resources; tropical fruits in abundance; with every variety of soil and climate as you ascend the mountain ranges; abundance of turtle and fish in the waters adjacent; plenty of game on the main land, the islands in the lagoon, and on the Pacific coast; with three practicable railroad routes across the Cordilleras, in addition to the cañon route surveyed by Lieutenant Morton, as I can state from personal observation, affording the best connexion for the commerce of the two oceans, this country offers a wide field for American enterprise, and is well worthy of the patronage of the government.

These coals have all the marked characteristics of brown coal, and their odor on burning is peculiar—the smell of amber or succinic acid being perceived in the smoke. On microscopic examination of their fragments, and of the ashes of the coal when burnt, the structure of cellular plants which formed it is discerned quite distinctly. The fossil plants, leaves, &c., associated with the coal were endogenous, allied to, or identical with those at present growing in the vicinity. The fossil shells are all eocene or miocene tertiary, (salt water shells;) none older were discovered in the coal formations.

In the characteristics of these coals and their location and geological age, we have a lesson in older geology of the coal formation. It is admitted that the secondary coal formation was produced under tropical climate. Now, the tertiary coals of Chiriqui were produced under exactly the same conditions in more modern times. In the north vegetable matters of tertiary epoch formed lignites and non-bituminous brown coals—for example, the Oregon coals—while the true coal formation in the northernmost countries, even under the Arctic circle, are bituminous, and are accompanied by plants that must have grown in a warm climate. The Chiriqui coals are good illustrations of the conditions required for bituminization of vegetable matters, so as to make true bituminous coals.

A careful analysis of the coals from the various localities indicated, made by Dr. Charles T. Jackson, of Boston, exhibits the following results:

Analysis of Blanco river coal.

Specific gravity, 1.341.

The coal yield per cent.—

Water	5.00
Volatile matter, gas	41.60
Fixed carbon	43.40
Ashes	10.00

100.00

The ashes consists of—

Silica and insol. silicates.....	6.80
Per oxide of iron and alumina.....	0.40
Carbonate of lime.....	0 52
Alkalies undetermined, and some carbon, which escaped combustion.....	2.28
	<hr/>
	10.00
	<hr/>

This coal is black splendid on fracture ; is compact in structure ; color, when reduced to fine powder, amber-brown. This coal burns with a very large, bright yellow flame. It is a good gas coal, and is suitable for steam-engines and for all ordinary uses. "It is a very nice, clean coal for the parlor grate."

Analysis of Chiriqui coal from Sierschick creek and Jinia creek, tributaries of the Changuinola river.

Specific gravity of the coal, 1.334.

Color of powder, amber-brown ; streak, the same.

One hundred parts, by weight, of this coal, yielded by analysis—	
Water.....	5.00
Bitumen and gas.....	42.60
Fixed carbon.....	43.40
Ashes of gray color.....	9.00
	<hr/>
	100.00
	<hr/>

This coal is well suited for steam-engines and all useful purposes ; it is compact and more stratified in structure than other specimens analyzed. The microscope shows it to be made up of cellular plants without any annual rings or other markings characteristic of exogenous trees.

Sierschick creek and Jinia creek, tributaries of the Changuinola river.

Eight seams of coal crop out on the Sierschick creek ; six of them are near enough to each other to be mined together. There are two in Jinia creek, and one lower down on the main Changuinola river.

The similarity of the coal on these two creeks, and the associated rocks and clays, renders it unnecessary to make sections of each ; one will suffice for both. The same similarity prevails in relation to the Blanco river coal, and therefore it does not require a separate section of the associated rocks.

The coal-field continues still further to the northwest, but no opportunity was afforded for further explorations.

The aggregate thickness of the eight seams in Sierschick creek is thirty feet ; of the six seams, which can be mined together, twenty-four feet. The seams in Jinia creek are eighteen inches, and two and a half feet in thickness ; they crop out at the water's edge for a long

distance along the shore-line of the creek, and the other seams exhibited on Sierschick creek are no doubt a short distance below them. The coal on Blanco river is exhibited in three seams, bearing the same general direction as those on Sierschick creek, and associated with the same rocks, clays, and fossils.

The six beds of coal referred to above are separated by seams of fine-grained buffish-colored clay; immediately adjacent to the coal are thin seams of slate-colored clay with fragments of coal. Above the last seam of coal is a bed of dark slate-colored clay, then a light ash-colored compact clay, with a greenish tinge, in some localities, containing numerous fossils of the tertiary period, such as *cardium*, *cerithium*, *arca*, *obeliscus*, *pinna*, *solen*, *natica*, &c. The dust or earthy matter upon these specimens is full of microscopic speculæ of sponge, which is found in great abundance in the adjacent waters of the Chiriqui lagoon. The fossil flora associated with the coal deposits is similar or closely allied to existing species in that vicinity.

This clay becomes very hard when exposed to the sun, but when wet is quite soft, rendering it difficult to secure specimens of fossil leaves and stems sufficiently perfect to be identified. They are, however, no doubt older tertiary, and similar to existing species. Next above this clay is a fine-grained limestone; then sandstone; next volcanic conglomerate; then soft bluish-gray sandstone; then slightly cemented boulders of primary rocks; next yellowish or buff-colored clay; then a very rich loamy soil from six to ten feet in thickness. Below the coal deposits the sandstone is of great thickness, say 500 feet; it is saliferous, and of the same geological age as the mountain ranges bordering the Umpqua valley on the west in Oregon.

Below this is a fine-grained and very compact limestone, resting on talcose and chlorite slates, and these on or against granitic or volcanic rocks. The more recent formations alluded to dip at an angle of 20° from these granitic or volcanic upheavals.

The bottom lands of the Changuinola river are very valuable for agricultural purposes, extending along the base of the Cordilleras for thirty miles in a northwest and southeast direction. This valley is well suited for stock raising, and as the southern fork connects with the cañon route for the proposed railroad across the isthmus, it affords perhaps greater inducements for settlement than any other portion of the Chiriqui isthmus.

It is a very wrong impression that the country is infested with venomous reptiles or insects. During my survey but two snakes were seen by my party whose bite was dangerous. This may be accounted for in part by the numerous bands of two species of peccary, which inhabit the islands of the Chiriqui lagoon and those adjacent to the Pacific coast, and on the main land intermediate. On the banks of every creek where access to water is practicable, the whole surface of the shore is indented with fresh tracks of these animals. Their scent is very strong, and can be perceived from a long distance. These animals, also like the buffalo of the west, must have some instinctive knowledge of the vicinity of the human species; for they succeed in avoiding the hunter almost invariably, unless he approaches them against the wind. Although we had undoubted evidence of their

vicinity in large bands in all the islands explored on the Pacific and Atlantic coasts, we succeeded in killing but two. It is well known to the naturalist that the peccary is impervious to the bite of the rattlesnake and other venomous serpents. They search for them eagerly, and eat them as food with impunity.

The native Indians are simple in their habits, and perfectly honest; their wives are kind-hearted and modest. Their palm-leaf huts are always open to the traveller, without cost, unless he insists upon paying, and then the price is at his own option. You may travel from the Atlantic to the Pacific ocean, and on all the islands adjacent in perfect security without any arms of defence. If you intrust the native Indian with money to purchase supplies, you are always certain of a quick and safe return, with prices much lower than you could purchase yourself.

Pope's (or Popa) island coal bed.

The coal in this locality is of great commercial importance, as it is accessible to sail and steam navigation. It crops out in a bay on the sea shore in two veins, dipping under the water, and at an angle of 20° to the northeast. These seams are separated by slaty clay twelve feet in thickness, and are respectively three feet and five and a half feet in thickness. The coal resembles the brown coal of the western States. It is a good coal, but the surface specimens are much deteriorated by the action of salt water, which covers the coal exposed on the beach at every tide. The specimen analyzed was taken from the banks of a creek having its outlet near the principal coal mine, but from a locality more inland, and although in some measure deteriorated by atmospheric influences, it had not been exposed to the action of salt water. Judging from the associated rocks exhibited along the shores, the coal formation must occupy the entire island.

The associated rocks and coals are as follows, viz:

	Feet.
No. 1. Soil - - - - -	3½
2. Yellowish clay with ferruginous bands - - -	12
3. Slaty clay with nodules of limestones containing fossils of tertiary period - - -	8
4. Slaty clay with fragments of coal - - -	3
5. Coal - - - - -	5½
6. Slaty clay - - - - -	12
7. Coal - - - - -	3
8. Slaty clay - - - - -	10
9. Coarse gray sandstone disappearing under the water.	

Analysis of Pope's island coal.

Sp: Gr: 1.366.

Analysis of 100 parts gives—

Water - - - - -	8.60
Coke - - - - -	51.60
Gas - - - - -	39.80
	<hr/>
	100.00
	<hr/>

Or—

Water	-	-	-	-	-	-	8.60
Coal gas	-	-	-	-	-	-	39.80
Fixed carbon	-	-	-	-	-	-	48.00
Ashes	-	-	-	-	-	-	3.60
							<hr/>
							100.00
							<hr/>

This is a good coal for steam-engines ; it burns with a bright, yellow flame, and gives forth the smell of amber when burnt. Microscopic inspection shows vegetable structure and cells of plants.

Secretary coal mine.

There are three seams of coal exhibited in this locality, in the vicinity of Valiente Point. The first is in a bluff on the shore of the lagoon, about eighteen feet above the beach, and is three feet in thickness. The second is about one mile to the northeast, at the water's edge, and is six feet in thickness, with three feet of black sand and clay mixed with fragments of coal below it. In this sand and clay are specks of gold and platinum. A few yards further east a third seam crops out on the shore two and a half feet in thickness. These coals are of a brownish color when taken from the veins, but become jet black when moistened with water. From the dip all these seams must come near the surface not far inland. The rocks, &c., associated with the coal are, viz :

No. 1.	Coal	-	-	-	-	-	-	4
2.	Buff-colored clay	-	-	-	-	-	-	20
3.	Ash-colored clay	-	-	-	-	-	-	6
4.	Coal resting on thin seams of ash-colored clay	-	-	-	-	-	-	3
5.	Clay of buff color with ferruginous bands	-	-	-	-	-	-	10
6.	Coarse-grained friable sandstone	-	-	-	-	-	-	12
7.	Slaty clay with fragments of coal	-	-	-	-	-	-	2
8.	Coal	-	-	-	-	-	-	6
9.	Clay and black sand with specks of coal	-	-	-	-	-	-	2
10.	Coarse-grained sandstone	-	-	-	-	-	-	12
11.	Coal	-	-	-	-	-	-	2½

This coal rests on a thin stratum of clay, and is underlaid by a coarse-grained sandstone. This coal is similar but somewhat inferior to the Pope's island coal.

Saddle Hill coal mine.

The coal on this promontory crops out in several localities embracing a distance of six miles. There are three seams at each exposure two and a half, three, and five feet in thickness. The coal is of a brownish color, and light in weight. The dip is from 15° to 20° to the northeast.

The section of rocks, &c., associated with the coal is as follows, viz:

								Feet.
No. 1.	Soil	-	-	-	-	-	-	3
2.	Yellowish clay	-	-	-	-	-	-	5
3.	Drift deposit, consisting of primary and igneous rocks, limestones, and sandstones imbedded in yellowish clay							10
4.	Coarse-grained gray sandstone	-	-	-	-	-	-	6
5.	Clay of slaty structure, containing small fragments of coal							21½
6.	Coal	-	-	-	-	-	-	3
7.	Clay of slaty structure	-	-	-	-	-	-	2
8.	Coal	-	-	-	-	-	-	2½
9.	Slaty clay	-	-	-	-	-	-	3
10.	Coal	-	-	-	-	-	-	5
11.	Slaty clay to water's edge, resting on coarse-grained sandstone.							

The seams here exhibited are higher in the series than Pope's island coal, and somewhat inferior in quality. The more valuable strata no doubt, will be found a short distance below, as indicated by the associated rocks and fossils.

Analysis of coal from Cultivation creek, Shepherd's harbor.

Water	-	-	-	-	-	-	6.00
Bitumen and gas	-	-	-	-	-	-	48.44
Fixed carbon	-	-	-	-	-	-	38.96
Gray ashes	-	-	-	-	-	-	6.60
Sulphur traces	-	-	-	-	-	-	
							<hr/> 100.00 <hr/>

The 6.6 qrs. ashes consists of—

Insoluble silicates	-	-	-	-	-	-	1.50
Peroxide of iron and al.	-	-	-	-	-	-	2.20
Carbonate of lime	-	-	-	-	-	-	1.50
Loss and sulphur	-	-	-	-	-	-	1.40
							<hr/> 6.60 <hr/>

This coal is compact, hard as desirable, has in mass a jet black color, but when powdered is of a brown color. Its specific gravity 1.316. This coal is suitable for steam-engines, and will produce heat with great rapidity. The coke is of good quality, and the ashes of small amount.

Elementary analysis of Cultivation creek coal, by means of black oxide of copper, and by the soda lime combustions, with organic analysis, apparatus, and re-agents.

Carbon	-	-	-	-	-	-	68.018
Hydrogen	-	-	-	-	-	-	6.480
Oxygen	-	-	-	-	-	-	17.858
Nitrogen	-	-	-	-	-	-	0.855
Sulphur	-	-	-	-	-	-	0.189
Ashes	-	-	-	-	-	-	6.600
							<hr/>
							100.000
							<hr/>

Aggregate thickness of the coal seams.

Eight seams of coal are exhibited on Sierschick creek, tributary of Changuinola river. The aggregate thickness of these seams is thirty feet - - - 30 feet.
Of these seams six can be mined together, twenty-four feet in thickness.

Pope's island, two seams	-	-	-	-	-	8 $\frac{1}{2}$	"
Secretary, three seams	-	-	-	-	-	11 $\frac{1}{2}$	"
Saddle Hill and vicinity, three seams	-	-	-	-	-	10 $\frac{1}{2}$	"
Jinia creek, two seams	-	-	-	-	-	4	"
Main Changuinola river, one seam	-	-	-	-	-	5	"
Cultivation creek, Shepherd's harbor, two seams	-	-	-	-	-	5	"
							<hr/>
							74 $\frac{1}{2}$
							"

The three seams exhibited on Blanco river are continuations of those exposed on Sierchick creek. The associated rocks, fossils, &c., are identical; they are not, therefore, included in stating the thickness of the coal deposit on the lands of the Chiriqui Improvement Company.

The coal basin thins out as you approach the volcanic rocks forming the dividing ridge of the Cordilleras, between the Atlantic and Pacific oceans. The veins in this locality present more the appearance of anthracite than bituminous coals. They are more compact, heavier, have less bitumen but more carbon in coke.

The structure of this mountain range is very evident to any one who stands on the dividing ridge in full view of the Atlantic and Pacific oceans and the intermediate country.

The Chiriqui volcano and the Boquete form centres from which radiate spurs that overlap each other, presenting from the Caribbean sea the appearance of three continuous mountain ranges, parallel to each other, barring communication with the Pacific coast. But from the divide you see numerous rivers, heading in these peaks, pursue their winding course around these spurs and between them, finding their way by comparatively gradual descent to the Chiriqui lagoon.

The dividing ridge is composed of basalt or trap. The overflow of

the basalt, of which there have been three distinct eruptions, extends to the Pacific and underlies the tertiary rocks and clays on that coast and its adjacent islands.

Near the volcano the soil is basaltic, resting on clays of the tertiary period. It is very rich in humus or vegetable mould, and contains all the saline ingredients of a first-rate soil. As you reach the savanna this soil increases in thickness and fertility. The clay is well suited for brick-making and pottery. In the short distance of thirty-five miles, in the upper portion of the savanna, you have every variety of climate and soil, well suited to wheat, Irish potatoes, and other products of our northern and middle States; towards the sea-coast, rice, cotton, tobacco, coffee, and all the fruits and productions of the southern States and of tropical climates are produced in abundance.

Rich specimens of gold in quartz and in black sand, copper, iron, platinum, and other valuable minerals, have been discovered in various localities; agates, jasper, opals, diamonds, similar to those used in Chinese ornaments, were found. Specimens of the coals, minerals, and precious stones, have been brought home, and will be deposited in the Smithsonian Institution, or any place which may be designated by the Secretary of the Navy for examination.

Healthfulness of the climate.

There is no prevailing disease between the Atlantic and Pacific coasts on the Isthmus of Chiriqui. During the whole of my explorations of the shore-line of the lagoon, the islands adjacent, the various rivers tributary, and in crossing and recrossing from the Atlantic and Pacific, not a single member of my party, either the men from the "Brooklyn" or natives, was sick. It is true that at the unfavorable locality of the "Mission House," at the mouth of Fish creek, with a marsh back of the settlement filled with water at every rain, and covered with vegetable matter in a state of decomposition, washed down from the adjacent mountains, constantly accumulating, and subjected to the heat of a tropical sun, cases of intermittent fever occurred, but they readily yielded to a few doses of quinine. Fatal cases, if any ever occur, are very rare. A similar unfavorable locality in any section of country would produce as great, if not greater, deleterious effects. My own hammock was swung, for ten nights, under a palm-leaf roof, elevated ten feet from the ground, with the land breeze passing over this swamp, and I suffered no inconvenience and not a moment's ill health.

The rainy season is a succession of sunshine and showers. If it rains in the morning, it is usually fair in the afternoon. And if it rains in the afternoon and night, it is bright in the morning and until three or four o'clock in the afternoon. Sea breezes prevail during the day, and land breezes at night. The thermometer varies from 67° to 87° during the year, and towards morning it is so cool that a blanket was comfortable every night during my sojourn on this isthmus.

Productions.

In describing the formation of the soil, I have already briefly alluded to the productions of the country; but it will not be out of place to refer to special localities and their rich producing qualities.

On the Atlantic side there are many streams flowing down from the mountains having bordering valleys; but the most beautiful and extensive are those of the Cricamola and of the Changuinola rivers. These vary from ten to twenty miles in width; their soil inexhaustible. Indigenous to it are cotton, tobacco, coffee, cacao, sugar-cane, rice, and all the tropical fruits. These do not grow in single crops, but in succession throughout the year. Under the hand of the cultivator four crops a year could readily be gathered, and of qualities inferior to none that earth produces.

Timber for ship-building.

There is a great variety of timber suitable for ship-building on the islands of the lagoon and the mainland bordering it. Mr. Shepherd, an old resident, engaged in canoe and ship building, has given me the following list of the most valuable: Santa Maria, cedar, dogwood, sunwood, Sambo gum, olive, red mangrove, black mangrove, white mangrove, mahoe, satin, sapadilla or bull's tree, timber sweet, yoke-wood, oak, and bastard cabbage tree.

These are the common names in that vicinity. Specimens have been collected of each variety. Specimens of these will be deposited in the Smithsonian Institution for inspection. Several of these woods are equal to the live-oak of the southern States for vessel frames, and others are superior to any that are within my knowledge for planking, owing to the quality of the wood and the great lengths they may be cut, these being from eighty to one hundred and twenty feet.

In concluding this brief statement of facts, permit me to express my grateful acknowledgments to Captain Farragut and the officers of the United States steamer Brooklyn, who furnished me with boats and men to aid in the performance of the duties assigned me. Captain Farragut furnished me with two experienced miners, from the fire department of the ship, who accompanied me in my researches for coal. One of them, David Pace, made the mining tools used, and his knowledge of the coals consumed in the United States and in Europe, in steam navigation, made his information and judgment of great value. Joshua Perkins, another man from the ship, accompanied me in most of my explorations, packed the same load as the natives, cooked and took care of the camp, and although he encountered many hardships, dangers, and pecuniary losses, he bore all with an uncomplaining spirit.

My friend and assistant, Mr. Lambert, rendered me important services in the construction of the accompanying map, and in the topography of the country explored. He also aided in barometrical and tidal observations at the "Mission House," on the Chiriqui lagoon.

Mr. Morel accompanied me to the coal localities, and but for his

information it would have required a much longer time to complete the examinations than was placed at my disposal.

Collections have been made of coals from different localities ; also the associated clays, rocks, and fossils. A hogshead of coal has been deposited at the Gosport navy yard ; also several boxes brought on to Washington, subject to the order of the Navy Department, or any further investigation that may be deemed necessary.

Specimens of the soils, gold, platinum, iron, copper, precious stones, &c., have also been collected.

I have the honor to be, very respectfully,

JOHN EVANS,
Geologist of the Chiriqui Commission.

This indenture, made this twenty-first day of May, A. D. 1859, between the United States, acting by and through Isaac Toucey, Secretary of the Navy of the United States, of the first part, and the Chiriqui Improvement Company and Ambrose W. Thompson, of the second part, witnesseth : That whereas the said Chiriqui Improvement Company and the said Thompson have become possessed of certain grants, concessions, privileges, rights, and properties at the isthmus of, and in the province of, Chiriqui, in the republic of New Granada, as appears by the original titles thereto, copies of which are hereto appended ; and whereas it is desirable that the United States, on the one part, should have the right of transit over the roadway granted direct to said Ambrose W. Thompson through said province, and extending from the Caribbean sea to the Pacific ocean, and the further right to use, as harbors, the waters, gulfs, bays, or lagoons sheltered or partially surrounded by the lands of the said Thompson or the said Improvement Company, and the further right to use the coal contained in portions of said lands, for naval purposes, as also the right to establish coal depots and naval stations : Therefore, in consideration of the payments and covenants hereinafter stipulated and set forth, it is mutually agreed between the parties aforesaid as follows :

First. The United States, for the consideration hereinafter named, shall have and enjoy a right of way or transit over said road, which is hereby granted to them by the party of the second part, free from all tolls or taxes upon officers, agents, seamen, landsmen, mails, munitions, stores, troops, or any direct property of the United States which the government thereof may transport or cause to be transported over the said road during the continuance of the present grant made by the said province of Chiriqui to the said Ambrose W. Thompson.

Second. It is hereby agreed, by and between the said parties of the first and second part, that there shall be selected and set apart such lands, not exceeding five thousand acres, on each side of the province or isthmus of Chiriqui as may be necessary for said United States for coal depots and naval stations at the lagoon of Chiriqui and the harbor of Golfito, the same to be located at such points as will secure good and sufficient depots and stations to the United States without impair-

ing the general value of any site for city or cities which may be laid off by said party of the second part on any of said lands. The said lands to be selected and designated either on the main land or islands, or both, as the United States may determine, and within twelve months from the date hereof; and the said party of the second part hereby conveys the said lands to be so selected to the United States, together with all the timber thereon, and covenants to execute such further conveyances as may be necessary to vest in them a good and sufficient title as derived from the said grants.

Third. The United States shall have the right, and the same is hereby conveyed, to use, as harbors, the waters of the lagoons, bays, or gulfs sheltered or partially surrounded by the lands of the said Thompson or the said Chiriqui Improvement Company, on the Atlantic and Pacific sides of the aforesaid isthmus, and in the bays and gulfs wherever the lands of the said Thompson or said company may extend.

Fourth. The United States shall have the right, and the same is hereby conveyed, to all coal, for naval purposes, at or near the points selected for coal depots and naval stations, as aforesaid; but if coal shall be found of superior quality for steam purposes in other places than those so selected, then the United States shall have the right, and the same is hereby conveyed, to use the same, subject only to the tax of one dime per ton, as provided to be paid to the provincial authorities of Chiriqui, in the grant aforesaid, and the cost of mining and delivering the same.

Fifth. The United States hereby agree, in consideration of a grant of a right of way and free transit over the said road, and for the harbors, lands, mines, concessions, privileges, rights, and enjoyments hereby made and conveyed to them, to pay to the said Ambrose W. Thompson, for himself and said Chiriqui Improvement Company, the sum of three hundred thousand dollars, provided Congress shall approve this contract and make the necessary appropriations therefor at its next session; otherwise this contract shall be void.

In witness whereof, the said Isaac Toucey, Secretary of the Navy, for and on the part of the United States government, and the said Ambrose W. Thompson, for himself, and as the duly authorized attorney in fact for the said Chiriqui Improvement Company, have signed, sealed, acknowledged, and delivered this agreement in duplicate the day, month, and year first herein written.

AMBROSE W. THOMPSON, [L. s.]
For himself and the Chiriqui Improvement Company.
 ISAAC TOUCEY, [L. s.]
Secretary of the Navy.

In presence of—
 CHAS. W. WELSH.

[On page 3, line 5 from the top, the word *twenty* was erased and the word *five* inserted therefor before the signing of this contract.]

LANDS ON THE PACIFIC.

Ordinance of October 20, 1852, granting a privilege to Señor Santiago Agnew for colonizing at Golfo Dulce.

The camara of the province of Chiriqui, considering the petition of Señor Santiago Agnew for establishing a colony at Golfo Dulce, and in use of attribution 3, article 3, of the law of June 3, 1848, upon municipal administration, ordains:

Article.—A privilege is hereby conceded to Señor Santiago Agnew for colonizing with native and foreign immigrants the lands lying between the river known as Las Esquinas and the river "Clara," or "Agua Clara," in the centre of Golfo Dulce, on the Pacific coast, with the sole condition that the inhabitants remain subject to the government of New Granada and to the authorities of the province; the aforesaid lands being a part of the province, and comprehended in the "Indulto" from the King of Spain.

Sect. 1. The grantee shall commence the founding of this colony within sixteen months from the date of the sanction of this ordinance.

Sect. 2. So soon as Señor Agnew shall commence to people the said lands he shall give notice to the government of the province, so that the necessary authorities and functionaries may be established in said locality.

Given at David this 18th day of October, 1852.

The President of the Legislature,

JOSÉ DEL CARMEN DE VILLAMAR I ORNA.

The Secretary,

MANUEL NICHOLAS DE SANTIAGO.

GOVERNMENT OF THE PROVINCE OF CHIRIQUI,

David, October 20, 1852.

Let this be executed and published.

ESCOLASTICO ROMERO. [SEAL.]

The Secretary,

IGNACIO BELTRAN.

I, José Maria de Alba, secretary to the government of the province of Chiriqui, certify that in the archives of this office, at present under my charge, there exists the original of the preceding ordinance, and that the foregoing is a true and faithful copy of said original.

JOSÉ MA. DE ALBA.

DAVID, *November 13, 1854.*

The governor of the province of Chiriqui certifies that Señor José Maria de Alba is truly the secretary to this government, and that the foregoing signature is really his, and the same which he habitually affixes to all public and private documents.

David, the 13th day of November, 1854.

SANTIAGO AGNEW. [SEAL.]

Ordinance of December 31, 1852, fixing the limits of the privilege granted to Señor Santiago Agnew for colonizing at Golfo Dulce.

The provincial camara of Chiriqui, considering the petition of Señor Santiago Agnew, by which he solicits an explanation as to the exact limits of the privilege which was conceded to him for establishing a colony at Golfo Dulce, upon the common or "Indulto" lands belonging to this province, and in use of the 3d attribution, article 3, of the law of June 3, 1848, regulating municipal administration, ordains:

Article.—The privilege conceded to Señor Santiago Agnew, for establishing a colony, by the ordinance of October 20 last, must be understood as having for limits to the territory which is therein conceded to him, a direct line drawn from the mouth of the river "de las Esquinas," in the centre of Golfo Dulce, to the summit of the Cordilleras, being the boundary line with Costa Rica; and a parallel line drawn from the mouth of the Rio "Clara," on the Pacific, to the summit of the Cordilleras, which is also one of the boundaries of the grant made to Messrs. Whiting & McDowell, by the ordinance of 22d of October last.

Given in the hall of sessions of the camara, at David, this 31st day of December, 1852.

The President,

AUGUSTINE JOVANE.

The Secretary,

MANUEL N. DE SANTIAGO.

GOVERNMENT OF THE PROVINCE OF CHIRIQUI,

David, December 31, 1852.

Let this be executed and published.

ESCOLASTICO ROMERO. [SEAL.]

The secretary,

RAMON LUNA.

I, José Maria de Alba, secretary to the government of the province of Chiriqui, certify that in the archives of this office, at present under my charge, there exists the original of the preceding ordinance, and that the foregoing is a faithful transcript of said original.

JOSÉ MA. DE ALBA.

" The governor of the province of Chiriqui certifies that Señor José Maria de Alba is truly the secretary to this government; that the foregoing signature is really his, and the same which he habitually affixes to all public and private documents.

David, the 13th day of November, 1854.

SANTIAGO AGNEW. [SEAL.]

UNITED STATES CONSULATE, *Panama, New Granada.*

I, Archibald B. Boyd, commercial agent for the United States of America at the port of Panama, republic of New Granada, do hereby certify that Santiago Agnew, whose name appears to the within

instruments of writing, is governor of the province of Chiriqui, republic of New Granada, within the limits of this consular jurisdiction, and that his acts as such are entitled to perfect faith and confidence. In testimony whereof, I hereunto sign my name and impress the seal of this consulate of Panama, this 11th day of December, A. D. 1854.

ARCH. B. BOYD,
Commercial Agent.

GOVERNMENT OF THE PROVINCE OF CHIRIQUI,
David, 4th of May, 1853.

Resolved, That in consideration of the accompanying memorial and the list of persons appended thereto, Señor Santiago Agnew proves that he has commenced to people the lands which were granted to him by the camara of this province, by ordinances of 20th of October and 31st of December of the year last past, for the purpose of colonizing them with native and foreign immigrants; I hereby declare the petitioner in full possession of the aforesaid privileges. Let information be at once given to the alcalde of the district of Alanje, under whose jurisdiction, for the present, the said colony comes, so that he may appoint a commissary or commissaries, as they may be required; and let him inform this government of what may be required for the political and judicial government of said colony, either in relation to its actual state or to the enlarged wants of the population as it may increase.

ROMERO.

In the absence of the secretary, the first clerk,
RAMON LUNA.

I, José Maria de Alba, secretary to the government of the province of Chiriqui, certify that in the archives of this office, at present under my charge, there exists the original of the preceding resolution, and that the foregoing is a true and faithful copy of the said original.

JOSÉ MA. DE ALBA.

DAVID, *November 13, 1854.*

The governor of the province of Chiriqui certifies that Señor José Maria de Alba is truly the secretary to this government; that the foregoing signature is really his, and the same which he habitually affixes to all public and private documents.

SANTIAGO AGNEW. [SEAL.]

DAVID, *November 13, 1854.*

UNITED STATES CONSULATE, *Panama, New Granada.*

I, Archibald B. Boyd, commercial agent for the United States of America at the port of Panama, republic of New Granada, do hereby certify that Santiago Agnew, whose name appears to the foregoing instrument of writing, is governor of the province of Chiriqui, republic

of New Granada, within the limits of this consular jurisdiction, and that his acts as such are entitled to perfect confidence and credit.

In testimony whereof, I hereunto sign my name and impress the seal of this consulate, at Panama, this 11th day of December, A. D. 1854.

ARCH. B. BOYD,
Commercial Agent.

LANDS ON THE ATLANTIC.

CABILDO OF THE DISTRICT OF BOCAS DEL TORO—ORDINARY SESSION.

Acuerdo of July 17, 1854, upon concession of vacant lands, and a privilege for a canal to Messrs. J. R. Morel & Co.

The cabildo of the district of Bocas del Toro, in use of the faculties conceded to it by article 29, paragraph 3, of the provincial constitution, and considering—

1st. That Messrs. James Alfonso Morel and John Eugene Flandin, under the firm of J. A. Morel & Co., requiring lands for the development of the coal mining operations they have commenced in this district, solicit a grant of the 25,000 fanegadas of vacant lands which belong to this district, in conformity with the law of Congress of 12th April, 1851.

2d. That the vast advantages which this district must derive from the full development of so important a branch of industry as that of coal mining, impel this "cabildo" to aid with all its resources the successful accomplishment of such vast enterprises, which must advance its well being, and, in accordance with articles 27 and 28 of the provincial constitution, enact—

ARTICLE 1. The 25,000 fanegadas of vacant lands belonging to the canton of Bocas del Toro, under the law of Congress of April 12, 1851, are hereby conceded in full property and possession to Messrs. James Alfonso Morel and John Eugene Flandin, under the firm of J. A. Morel & Co.

ART. 2. Said 25,000 fanegadas of land are situate between the creeks known as "Banana" and "Splithill," the river "Culebra," and the "Cordilleras."

ART. 3. Messrs. J. A. Morel & Co. obligate themselves to pay into the treasury of the district the value of one dime for each ton of coal (of 2,000) pounds which shall be exported; and when the quantity so exported shall have reached ten thousand (10,000) tons, then they are to pay only half a dime per ton.

ART. 4. The above specified payment shall be made regularly every six months to the treasurer of the district; and Messrs. J. A. Morel & Co., or their representatives, shall keep a book, open to the inspection of said treasurer, wherein the quantity of coal exported shall be regularly recorded.

ART. 5. In consideration of the payment herein above recited, Messrs. J. A. Morel & Co., or their representatives, shall be exempt

from all district or municipal taxes, of whatever nature they may be, whether upon houses, stores, vessels, machinery, works, and persons; and, in short, upon all and everything that may be necessary to their enterprise.

ART. 6. Acting under the provisions of article 29, paragraph 4, of the provincial constitution, an exclusive privilege for twenty-five years to open a communication from the river Changuinola to this lagoon is hereby granted to the same Messrs. J. A. Morel & Co., and they shall have full right of property and possession, as well as an exclusive right of way to said communication, during the time of this privilege, as specified; after which it shall revert to the district.

ART. 7. The exclusive privilege given by this "cabildo," under date of 1st May, 1852, to the same Mr. A. Morel, and for the same purpose, is hereby revoked and annulled.

ART. 8. An original proof of this "acuerdo" shall be handed to Messrs. J. A. Morel & Co., to serve them as title deed in case of necessity.

Given at Bocas del Toro this 14th day of July, 1854.

President of the Cabildo,

PETER SHEPHERD, JR.

The Secretary,

GASPAR CERVERA.

ALCALDIA OF THE DISTRICT,
Bocas del Toro, July 17, 1854.

Let this be complied with and published.

The Alcalde,

JUAN JOSÉ LOPEZ. [SEAL.]

ALCALDIA OF THE DISTRICT.

I, Juan José Lopez, alcalde of this district of Bocas del Toro, hereby certify that in the archives of this alcaldia, at this day under my charge, there exists an original of the "acuerdo" passed by the "cabildo" of the district during its sessions of the month of July last past, making certain concessions to Messrs. J. A. Morel & Co., the tenor of which is, to the letter, like the preceding document, which is an exact and faithful copy of the said original, and to which at any time it may be referred; and at the request of Messrs. J. A. Morel & Co. I extend this present certified copy, at Bocas del Toro, this 9th day of October, 1854.

JUAN JOSÉ LOPEZ.

I, Geo. W. Fletcher, consul of the United States of America for the port of Colon (Aspinwall) and its dependencies, republic of New Granada, hereby certify that the signature above recorded is truly that of Señor Juan José Lopez, alcalde of Bocas del Toro, and as such is entitled to full faith and credit.

In witness whereof, I have hereunto affixed my hand and the consular seal this 20th day of November, A. D. 1854.

[SEAL.]

GEO. W. FLETCHER.

[Translation]

GRANADIAN LEGATION IN THE UNITED STATES.

The undersigned, envoy extraordinary and minister plenipotentiary of the Granadian confederation near the government of the United States, in view of the inquiry directed to this legation by Mr. Ambrose W. Thompson, dated the 4th of the present month, and upon examination of the documents to which reference is made, namely :

1. A certified copy of the ordinance issued by the provincial legislature of Chiriqui, on the 20th of February, 1854, granting the exclusive privilege to Mr. Ambrose W. Thompson to improve the provincial road from David to the Chiriqui lagoon; and

2. The original papers, showing the right of property in the coal mines, Siegi, Sierschick, Jenia, Changuinola, Xixcola, Banana, Jones, Cultivation, Split Hill, Sandy, Suariana, and Luncoo, issued in favor of Messrs. Santiago, Alfonso, Morel and Company, by the governor of Chiriqui, on the 16th of August and 3d of October, 1854, and legally transferred to the company, denominated the "Chiriqui Improvement Company."

I certify—

1. That the aforesaid documents are authentic, and as such are entitled to full faith and credit.

2. That the titles to the lands granted by the ordinance mentioned are regulated by Granadian legislation; and in order to have granted the titles to the coal mines above mentioned, they have observed the formalities prescribed by law 10, part 4, section 5, of the Granadian code; this opinion, in both its parts, being in accord with the written opinion given by Mr. Justo Arosemens, a Granadian lawyer of acknowledged ability.

3. That when these concessions and grants were made, "Chiriqui" was a province of New Granada, and as such had a provincial legislature, or chamber, and a governor.

4. That at that time the province of Chiriqui possessed two classes of lands—those called the "Indulto," which were granted by the King of Spain to the ancient province of Veragua, in 1705; and one part of these belonged to the province of "Chiriqui" when it was created, in 1849; and the "Tierras Baldeas," or *vacant lands*, granted by the congress of the republic to all the provinces.

5. That the provincial legislature of Chiriqui had full power to make these grants of lands, and such privileges as those made in favor of Mr. Thompson; and the governor of the province had power to grant titles to the mines in the form in which they were granted in favor of Messrs. Santiago, Alfonso, Morel & Co., in virtue of the existing law 10, part 4, section 5, of the Granadian code; and

6. That by the federal constitution foreigners enjoy in the Granadian confederation the same civil rights as their own citizens; being therefore in the same condition that they are, to buy, to possess, and to sell real estate. Besides, the policy of the Granadian government has alway been very liberal, and it has not hesitated to facilitate and

protect, as far as possible, the commerce of all nations, thus, at the same time, stimulating that of the republic.

In addition to the foregoing certificate, I avail myself, with great pleasure, of this opportunity to give testimony, that from information, official and private, worthy of all belief, or from my own information, I am of opinion that there are few countries in the world that possess so many elements of prosperity and wealth as that part of the State of Panama which forms the province of Chiriqui. In proof of this it is sufficient to mention its interoceanic position, the variety and comparative softness of its climate, which is most salubrious, especially in the mountainous parts, which enjoy a very fresh and bracing temperature, and in the southern part is almost populated, level, covered with grass and flowers, and abounding in flocks and herds; whilst the northern part only awaits the hand of civilized man to become no less healthful and desirable, and perhaps still better populated.

The mines of gold, from which Christopher Columbus carried with him specimens to Spain, yet remain to testify the existence of that precious metal in the gorges and ravines of the mountains; the mines of copper, of iron, of coal, and the various mineral springs which exist between the town of David and Bocas del Toro; the gum elastic, the pearls and pearl oysters, and the tortoise, furnishing the tortoise shell, abound on those coasts, in which there is already considerable commerce; the richest and most valuable dye-woods, timber for building, and especially ship timber, and resinous and medicinal woods, besides all those resources to make living easy and cheap. The most abundant game invite the chase, and all the fruits and products of the intertropical zone, from the papa, Indian corn, and garden products, to that of cocoa, the plaintain, the arrowroot, the cacao, the coffee, the cotton, the sugar-cane, besides many other things to which other countries now owe their wealth and prosperity; the facility of communication, especially on the Pacific side, whilst Panama and Punta Arenas furnish convenient and secure markets for the stock and all the articles of food from Chiriqui, there being between the town of David and Panama a level road, with abundance of water, and well populated—a people simple in their manners and habits, and principally engaged in agricultural industry and pastoral husbandry, and, therefore, peaceful and moral; and, finally, the magnificent entrance to this beautiful region, which Providence has arranged and the Granadian government has opened to all nations, is through Chiriqui lagoon and Admiral bay, an immense double bay, with fertile shores, one hundred and twelve miles in circumference, into which no less than twelve rivers empty themselves. Numerous harbors, among which there are two of the most commodious and secure in the world. Near to these are the coal mines, whose titles I have already certified, and they alone in the present epoch would be sufficient to render prosperous, as well as an object of desire, any country which may possess them.

A country which, in only that part of it which is known, can show such natural advantages and resources, cannot do less than to reward most prodigally the peaceful emigrant who may employ in it his capital, his intelligence, and his activity; and it is not necessary to

be a prophet to predict with certainty that this region will be, at no distant day, one of the richest marts in the world.

I must add that all that I have here written of Chiriqui is confirmed by the labors of the scientific commission, which, by order of the Granadian government, are now concluding, under the direction of General Cordazzi, a chorographical and topographical description of the confederation.

I cannot omit speaking of one circumstance more, which occurs to me, in favor of Chiriqui, and that is its contiguity to a neighboring people, laborious, peaceful, and well accredited as are those of Costa Rica, which owes to its own efforts, since its independence, all its prosperity.

These two countries are evidently destined by nature to mutually assist and enrich each other.

P. A. HERRAN. [SEAL.]

WASHINGTON, *April 8, 1859.*

Decree approving of the treaty of friendship, commerce, navigation, and boundaries between New Granada and Costa Rica.

The senate and house of representatives of New Granada in congress assembled, considering the treaty of amity, commerce, navigation, and boundaries between New Granada and Costa Rica, concluded by the respective plenipotentiaries, at San José, on the 11th of June, 1856, the tenor of which, word for word, is as follows:

(After reciting the treaty, the congress passed the following :)

DECREE.

ARTICLE 1. The foregoing treaty is approved in all its parts, so that it may be ratified and exchanged in accordance with this decree.

ARTICLE 2. The executive will see that, at the time of the exchange of ratifications, the Granadian plenipotentiary who may have charge of it shall make to Costa Rica the following declarations in the name of New Granada:

1st. That the river Doraces, Dorces, or Dorados, designed by article 41 as the dividing line of the two republics on the Atlantic side, is the first river a short distance to the east of Monkey Point; and that whatever doubts might ever arise on that point shall be solved in accordance with this present declaration, and based upon the hydrographic chart under view at the time the said treaty was negotiated, and the title of which is "Special Chart of the Sea of the Antilles and the Coast of Terra Firma, from the Island of Trinidad to the Gulf of Honduras, constructed in the Hydrographic Department, and published by superior order in Madrid, 1805. Corrected, 1809."

2d. That the grants of lands or *other properties* made in the neighborhood of Golfo Dulce, made legally in favor of individuals by the corporations or authorities of New Granada *prior* to the signing of this treaty, shall be *in the future as valid as if made by the government*

of Costa Rica; and, consequently, *the parties interested in such grants shall at no time be disturbed in their enjoyment of them.*

3d. That, as a general rule, the titles of individuals, which may be in existence as regards either lands or properties which Costa Rica may become possessed of under this treaty, shall be respected by that republic, *whether said titles be founded in strict law or on simple principles of equity.*

ARTICLE 3. The executive will see that the ratifications of the above treaty be not exchanged unless the stipulations in article two of this decree shall have been accepted by the plenipotentiary of Costa Rica.

Given, &c., &c.

The above law was discussed and approved by both houses, with the addition of article four, which stipulates that the time for the exchange of ratifications can be extended if required.

RAILROAD GRANT.

Inasmuch as the president of the republic of Costa Rica, competently authorized by the decree of the legislative chambers, which literally declares, No. 3:

The senate and house of representatives of the republic of Costa Rica, assembled in congress, in the exercise of the power conferred on them in the fourth clause of the ninetieth article of the constitution, single article, decree:

That the executive power is authorized to conclude with Mr. Thomas Francis Meagher, agent and representative of Mr. Ambrose W. Thompson, a citizen of the United States, a contract for the construction of a railroad between Boca del Toro and Golfo Dulce, conforming in every respect with the bases which, having been approved of, are annexed.

To the Chamber of Senators:

Given in their hall of sessions, in the city of San José, on the ninth day of the month of July, one thousand eight hundred and sixty.

JULIAN VOLIO, *President.*

DEMETRIO IGLESIAS, *Secretary.*

ANDRES SAENZ, *Secretary.*

Referred to the executive power. Chamber of senators, July 13, 1860.

MANUEL J. CARAZO, *President.*

J. S. RAMIREZ, *Secretary.*

FRANCISCO MONTEALEGRE, *Secretary.*

Let it be executed.

JOSÉ MA. MONTEALEGRE.

The secretary of state for hacienda, Vicente Aguilar, has given, in consequence thereof, plenary powers to Vicente Aguilar, secretary of state in the department of hacienda, war, navy, and public roads, to

proceed to the conclusion of a contract, referred to in the foregoing decree, with Mr. Thomas Francis Meagher, agent and representative of Mr. Ambrose W. Thompson, a citizen of the United States.

The commissioners of both parts, having met for this purpose, and having examined the bases approved of by the legislative chambers, in conformity with them, have agreed to the following—

CONTRACT.

ARTICLE 1. The grants of lands and privileges, which shall hereinafter be set forth, in nowise affect nor impair the rights of Costa Rica over that portion of the territory which is this day in dispute with New Granada; neither shall they involve the former at any time into any responsibility, whether with the latter or with the grantees, as to the final issue of the said territorial question, nor shall they stand in the way of the settlement of the boundary question. This, notwithstanding the stipulations in favor of the government of Costa Rica, to be mentioned in articles subsequent, shall remain valid and in full force.

ART. 2. The republic of Costa Rica grants to Ambrose W. Thompson and his associates the exclusive right, and for the term of sixty years, of constructing, using, and directing a railroad between the Pacific and Atlantic oceans.

The southern terminus of said road shall be at the point most convenient between "Punta Mala," or "Bahia de Coronado," as it is laid down in Kiepert's map, and the dividing line between Costa Rica and New Granada.

The northern terminus shall be upon the dividing line aforesaid, in the direction of the "Bahia del Almirante," or the "Lagoon of Chiriqui," or the coast of the Atlantic, between "Punta Uvita" or "Caouita," according to the same map and the dividing line already referred to.

ART. 3. There is hereby granted to Ambrose W. Thompson a belt of land of one hundred varas broad for the bed of the railroad, and the purposes therewith connected; and there is also granted to him a belt of land of one mile in breadth or depth on each side of the hundred varas granted for the railroad, which belt or zone shall be divided into equal squares, each square being one mile front on the railroad, and the depth of such mile shall comprise the third part of a league of five thousand varas, Spanish measurement.

Of the said alternate squares or sections, as will be seen further on, one-half is granted to Ambrose W. Thompson in absolute proprietorship; the government reserving to itself the other half of the lots, that is to say, the remaining sections, for the benefit of the nation.

Of the sections or squares reserved for the said government it shall take those which may be necessary, or such part of any one of them as may be required, save and except the two which at the termini of the railroad are allotted for depots, stopping places, and stations indispensable to the said road. For the purpose of distinguishing between the sections or squares, they shall be numbered from one upward on

each side of the road, beginning the enumeration from the first and carried on in the form exhibited by the following scale:

Stat'n res'vd to gran	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Reserved station	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

The even numbers on the north side and the odd ones on the south side of the road shall belong to the government, to be used for whatever purpose it may deem expedient, and the others shall belong to the grantee; but in exchange for the alternate sections which may be reserved for the government, it shall, instead thereof, grant such equal quantity of land to Mr. Thompson as he may require, out of those which are the property of the nation, and at a distance no less than that of two leagues from the coast and from the railroad, and in subdivisions in squares if possible, and which shall not be less than nine miles, also square.

ART. 4 The railroad shall be constructed on the best approved principles, in a firm, solid, and stable manner, and with all such works as its character requires, such as iron or stone bridges, embankments, culverts, &c.; nor shall its construction cause any expense to the republic of Costa Rica.

In consideration of the privileges and favors granted by the republic, the grantee or grantees shall transport at all times free of expense by the said route the officers of the government, members of the supreme powers, troops, munitions of war, mails, messengers and property of the government of Costa Rica.

ART. 5. All the products, whether the result of the natural growth or of the industry of Costa Rica, that may be exported over the railroad shall be entitled to the privilege of ten per cent. reduction on freight or carriage.

ART. 6. The company, under these grants, binds itself to charge only half passage price for those poor emigrants whom the government of Costa Rica, or it may be private companies or individuals duly authorized by the same, may introduce for the purpose of establishing themselves in the territory of the republic.

The government, concurrently with the grantee, will adopt all proper measures to prevent the commission of frauds to the injury of the company.

ART. 7. The survey and laying out of the road shall be completed within two years, reckoning from the date in which this contract will have been approved by the congress of the republic; and the road must be constructed and be thrown open to the transit and traffic of locomotives within the six years following, otherwise the grants and privileges, made by the government by virtue of the present contract, shall be null and of no effect, and all the favors conceded to the grantees shall revert to the government without giving rise on their part to any claim or indemnification.

Should, however, the survey and construction be interrupted by war, by pestilence, or by great natural obstructions, which it might be necessary to remove, or by violent storms, which might destroy the

works already commenced, then the government of Costa Rica, having these facts duly affirmed and proved to them, will grant two years more for the construction of the road, and these two years shall be considered *unproroguable* whatever causes may thereafter be alleged.

ART. 8. The grantees shall appoint and keep up at their own cost a body of police along the entire line of the railroad, as much for its protection as for the maintenance of order on it, but the government of this republic, concurrently with the grantees, will determine the number of this force, and its organization and discipline shall be subject to the approbation of the government of the republic.

ART. 9. The ports already established, or which may be established at either terminus of the railroad, shall be considered to be free ports, and shall be subject only to such imposts as are indispensable for their support, and those which the inhabitants, with permission of the government of Costa Rica, impose upon themselves for the same purpose or as municipal revenue.

ART. 10. In case of any necessity arising for the indemnification (?) of private property for the railroad, or for the framing of the sections or squares of land mentioned in article three, the grantee shall have a right thereto; but he shall pay for it according to its just valuation, which, should he and the owner not arrange amicably, shall be determined by arbitrators appointed by both parties, and the whole procedure to be in conformity with the provisions of the 25th article of the constitution.

ART. 11. The company being organized, and the railroad referred to in this contract being completed, that is to say, from the time of its being thrown open to traffic and public transit, the aforesaid company shall pay every year to the government of Costa Rica six per cent. on the net proceeds of the enterprise.

This payment shall be made semi-annually to the officer designated by the government, and be accompanied with statements of accounts, setting forth the amount received for the transportation of mails, for the sum total of tonnage of goods, and that of passengers sent over the road within the last six preceding months, without calculating any interest on the capital invested in the construction of the railroad and all its appurtenances.

ART. 12. In order to promote the interests of humanity, the company shall have the power to construct, or may permit to be constructed, in any portion of their lands, hospitals for the reception and cure of sick seamen, or others of any other country, who may ask for admission therein.

Said hospitals shall be administered under such regulations as the company and the physicians in charge of them may deem expedient.

ART. 13. The contracts or agreements made by Ambrose W. Thompson, or by his representatives, with any other individuals, whether in foreign countries, for service on the property or works of the grantee, or by the company formed by him or under his direction, shall have and retain all the legal force which said contracts or agreements might have in the place where they may have been made, and their respective obligations shall be faithfully observed in the territory of Costa Rica.

ART. 14. The grantees shall not at any time be permitted to disembark or transport, nor consent to the transportation or disembarkation, at any time whatsoever, across the railroad, of troops, arms, munitions of war belonging to any foreign government, or to individuals or private societies, [companies.]

The republic of Costa Rica only shall possess this right.

The infraction of this article by the grantees, their agents, or those charged with the direction and administration of the enterprise, shall forthwith work as a complete nullity and forfeiture of the present contract in all and every one of its parts, and the confiscation not only of such arms and munitions of war, but also of the railroad and all its works and fixtures.

ART. 15. Upon a preliminary measurement, at the expense of the parties interested, and made by surveyors appointed by the government of Costa Rica, said government shall issue, free of cost, the title-deeds to the ownership of the lands granted by virtue of the present contract, putting the grantees in possession thereof immediately upon their having thrown open the railroad to public traffic, and upon such opening being in conformity with the conditions stipulated for it in article 4.

ART. 16. During the two years provided for in article 7 of this contract for the survey and laying out of the line of the railroad, the republic shall not permit the denunciation of any vacant public lands, nor shall it make grants thereof, in the direction of that portion of them where the railroad is intended to run, in conformity with the limitations of article 2.

ART. 17. The railroad being finished, the grantees shall make a formal inventory of the implements, buildings, works, &c., belonging and appertaining thereto, which inventory shall be submitted to the government of the republic; and it shall be the duty of the said grantees to do the same at the end of each year, setting forth the improvements, &c., that may have been made in the preceding year.

ART. 18. The grantees at no time shall be at liberty, under penalty of forfeiting all the privileges of this contract, to transfer or to cede to any foreign government the grant of concessions and privileges made to them by virtue of the present contract.

ART. 19. On the expiration of the sixty years granted to Mr. Thompson and his associates, as also in the event of any of the occurrences as described in articles 7, 15, and 18 of this contract, the government of Costa Rica shall enter absolute possession of the railroad and all its appurtenances, such as wharves, bridges, offices, embankments, warehouses, trains, &c., &c., as well as also of the hospitals which may have been established in connexion therewith.

ART. 20. The grantees, as a guarantee for the fulfilment of the obligations incurred by the present contract, shall deposit in the national treasury of the republic, six months after the approval thereof by congress, the sum of one hundred thousand dollars in cash, which amount shall be returned to them in the same form and without interest on the completion of the railroad.

In case the grantees do not carry out the stipulations of this contract in all and every one of the parts, they shall forfeit the aforesaid

sum of one hundred thousand dollars, and the same shall belong, by unquestionable right, to the republic of Costa Rica.

ART. 21. In case of disagreements or disputes as to the understanding of any one or all of the articles of the present contract, it is hereby agreed by the two contracting parties to submit the point of difference to the supreme tribunal or court of justice of the republic of Chili for decision; and any point being decided by it, from such decision there shall be no appeal.

Done in National Palace, in San José, the capital of Costa Rica, on the 24th day of July, 1860.

VICENTE AGUILAR.

THOMAS FRANCIS MEAGHER.